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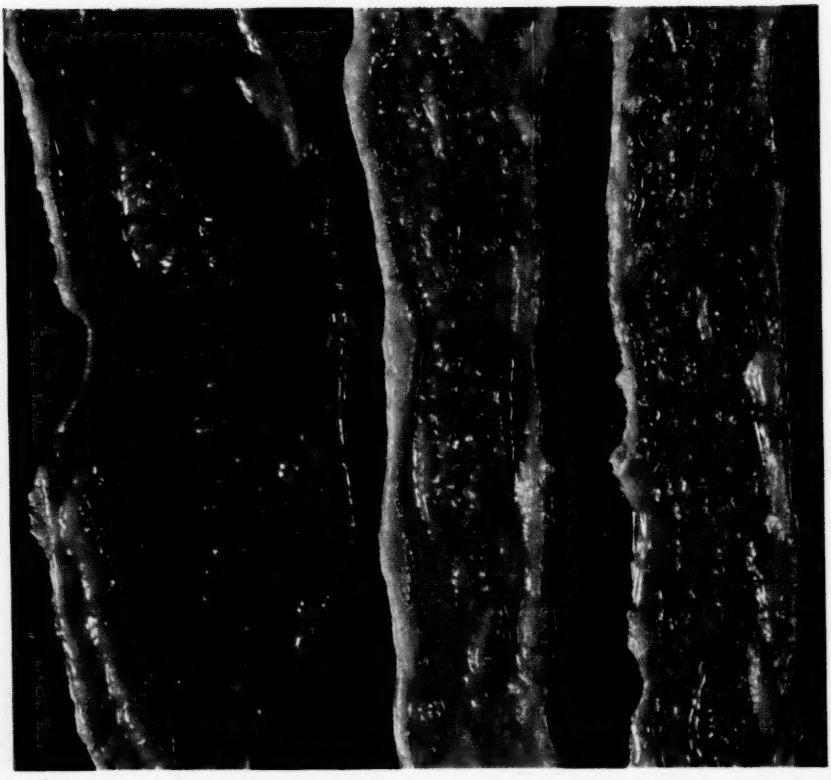

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Transilluminated Color Backgrounds In Medical Photography

by John J. Beiter and Milton G. Bohrod, M.D.*

GOOD medical photography has a two-fold purpose. First, and above everything else: it must present the medical features which it is desired to portray in as clear and striking a fashion as possible. Second: within the limits set by the first condition, it must produce pictures which are esthetically good.† The proper background for the picture can assist in arriving at both of these aims. A good background is unobstrusive yet pleasing, and offers sufficient contrast to set off the subject prominently.

In black and white photography the only available backgrounds were white, black, or occasionally some shade of gray. Contrast was achieved by differences in light intensity. When the subject itself presented great variability in light intensity the best compromise in the background still sometimes obscured one or more details. These same backgrounds are still used for the most part in color photography and with about the same results; with perhaps the additional disadvantage in the latter that the white background tends to glare and to obscure some fine details.

In color photography, however, a much greater range of possibilities is available for backgrounds. Color, rather than intensity, may be used to emphasize the subject, and when this is combined with variations in intensity the range of background material is increased many fold. All this is nothing new in general photography, but it has been somewhat neglected in medical photography. Colored cards were used by Drs. Levinson and Brown at the University of Illinois College of Medicine with pleasing results, and others have undoubtedly used them. Our use of transilluminated colored glass further extends the range and makes

*From the Department of Photography of the Laboratories of the Rochester General Hospital, Rochester, New York. Received for publication March 17, 1944.

†It is our belief that these two sometimes conflicting aims are best resolved by the intimate cooperation of a physician who is interested in photography and a photographer who knows something about disease. In our own work, debates over the medical and the photographic ideals have been at times almost violent, but the result is far better pictures than either of us alone could possibly achieve.

it possible to eliminate shadows about the photographed object if this is desired.

Our work has been mainly with pathologic specimens and our apparatus and methods are therefore primarily adjusted for this purpose. We have, however, successfully adapted the same principles to clinical and other types of medical photography by slight modifications which the medical photographer can no doubt supply for himself.

METHOD

Any diffusely illuminated box such as is frequently used in this kind of photography will be adequate. Our box is 18 x 16 inches and is 12 inches high, rests horizontally on the floor, the sides are perforated for ventilation and the lights so arranged that an opal glass 5 inches above them produces an even diffuse illumination, figure 1. A piece of plate glass is used to hold the object; this is placed at least 5 inches above the opal glass so that the latter is below the depth of field. The horizontal box has slots cut into the corner posts on one side just above the opal glass so that a second glass may be inserted or removed as desired.[1] The color-glass sheets we use are 18 x 16 x ⅛ inches, and we have a variety of them: light blue, dark blue, green, yellow, orange red and ruby, these giving us the colored backgrounds we usually wish to obtain. If only the opal glass is used, in combination with the lights below it, the resulting color temperature is about 3250° Kelvin, producing a white background on Kodachrome professional Type B film.[2]

The depth of the particular color background selected can be controlled by the lights (3200°K) that are used for incident illumination. If a darker shade is desired the lights are moved closer. Obviously, the subject then requires a shorter exposure and, since the light in the box is constant, the color background is underexposed, therefore recording as a darker shade. Conversely, if a lighter shade is desired, the lights are moved farther away. If a flash technic is used the background should be much lighter than for Mazda illumination. We use Number 22 G.E. or Number 2 Wabash, both requiring a 2 A Wratten filter to lower the color temperature to 3200° Kelvin.

To obtain the correct exposure, the customary procedure is followed using an exposure meter, except that the background illumination *must*

[1] This same principle is followed in the photography of a face, shoulder, etc., only we use a vertical illuminator, on a stand with rollers.

[2] Nearly all of our work has been with 3¼ x 4¼ or occasionally 5 x 7 film. In our opinion the better results obtained justify the greater cost over miniature film.

be turned off at the time the reading is taken. Failure to observe this important rule will allow excess light to enter the photo-electric cell, the result being too high a foot-candle reading. If the object to be photographed is less than twice the diameter of the cell, an incorrectly low reading may be obtained. However, in the majority of cases, unless the object is extremely light or dark, if the photographer holds his hand directly under the glass plate beneath the object the outer fringes of the cell will register the incident light from his hand, thereby compensating for the small size of the object.

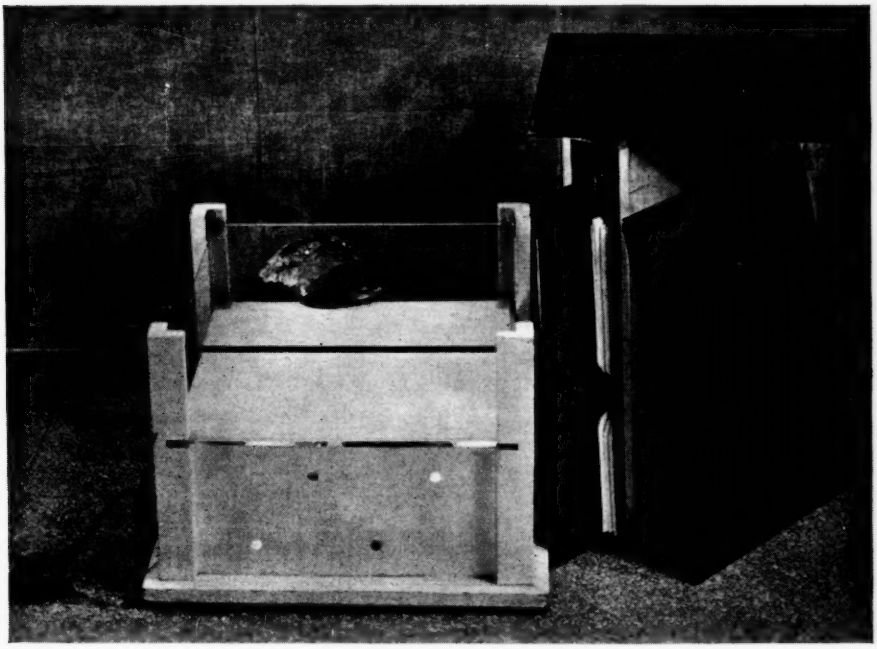

Figure 1

The most commonly used method of judging the lighting and composition of a subject to be photographed is, of course, to look at the subject with the eye as well as on the ground glass or in the view finder. This same procedure can be followed when attempting to determine the most desirable background to render the subject in the most pleasing and effective way. We have often made errors by accepting only the appearance to the eye. The ground glass appearance of the image was however, found to be very reliable. The most important factors to consider are: (1) to note the contrast desired; generally a background should be chosen of a complementary color to the specimen; (2) to

use a shade of the chosen color that is different in density from the subject.

DISCUSSION

Our earliest experiments soon demonstrated that the introduction of even the smallest amount of color in the background, produced very much more pleasing results. In looking back on our pictures of the pre-color background period, we are annoyed by the glare and displeased by the general effect. Without exception, both photographers and physicians find the color background immeasurably more pleasing than the white or black.

Although the non-illuminated color background was in general effective, there was still the problem of poor shadows and the dull, somewhat muddy color of the backgrounds. The latter objection was removed by transillumination, and where we wanted the impression of third dismension, we obtained it by good placing of highlights and controlling the shadows directly in the different parts of the subject.

One of the early problems was the proper choice of density of background. Often the color of the background on the final Kodachrome was many shades lighter than we had anticipated, especially with dark subjects. This was, of course, due to the long exposure required and we should perhaps have anticipated it. In general, therefore, we were compelled to use a somewhat darker background for these dark subjects. With very light subjects, conditions were reversed and our backgrounds were sometimes too dark. Later, as the reasons for these results became apparent, we used variations of total amount of incident light purposefully in varying the density of the background.

Beyond the esthetic effect, probably the greatest single advantage of the colored backgrounds is in the recording of subjects with two important features, one very light, the other very dark. In our work this happens particularly in photographing a light heart and almost black lungs together; or in a white brain with areas of dark red, almost black hemorrhage which extend to the margin of the specimen. In such cases color solves the difficulty; as a matter of fact we have used both dark and light backgrounds for such specimens, and as long as the color was different the results were good. Where there are intermediate densities in the subject the advantage is even greater, because here the intermediate gray which one might otherwise use would not give good contrast.

Choice of color background is somewhat dependent upon the coldness or warmness of the subject and this we controlled by choosing the opposite to the subject in the background. For most of our gross pathologic material, due to the predominence of reds and yellows, we found that some shade of blue gave the best results. Nevertheless, with

certain specimens such as transparent or translucent crystalline stones with a clear, cold tone, warm red backgrounds gave excellent results. Very black specimens with a small amount of red, or a yellow, fixed specimen of cross section of brain, gave good rendering with a light green background.

In the use of transilluminated color backgrounds for clinical photography our experiences have been similar. The pathologic condition usually has some shade of red, greenish gray or yellow. Here also, some shade of blue was generally found to be most favorable. No one background will best bring out the desired features in all subjects, and the type of color background, illuminated by transmitted light, should depend upon just what features one desires to emphasize.

While the appearance of the color background will, no doubt, be striking to the photographer, our experience has been that the average physician for whom the slides are used hardly notices them, when they are properly chosen, and merely notes the natural and pleasing appearance of the recorded subject. This is, of course, the proper end to be desired.

☆

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A Polaroid Dissolving Shutter for Amateur Movie Cameras

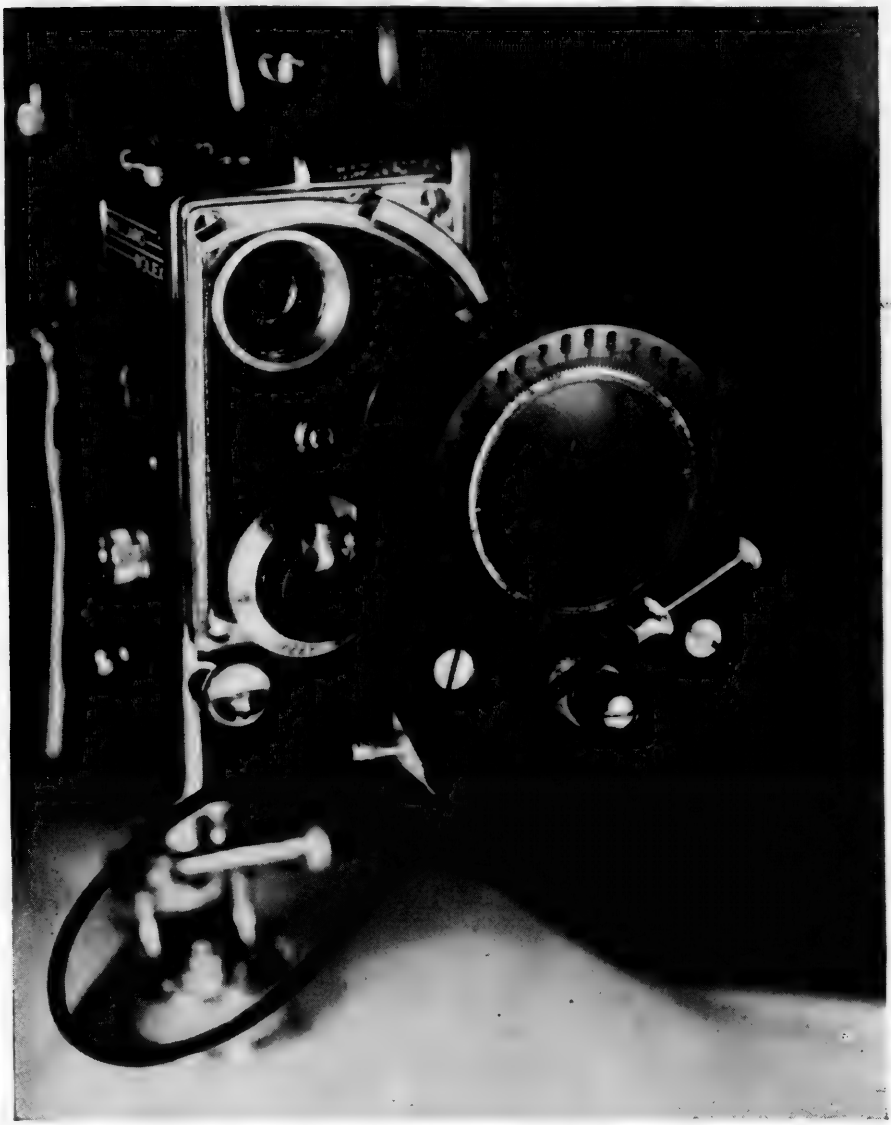
by Lorus J. Milne*

A DISSOLVING shutter is a device whereby the operator of a motion picture camera can control the amount of light reaching the film, without changing the setting of the lens diaphragm. Usually it is a means of reducing the angular aperture of the rotary shutter, incorporated by the factory in professional cameras, and operated manually and/or automatically. No eight millimeter camera is so equipped. The Eastman Cine-Special (16 mm) has a manually controlled dissolving shutter with four settings (170°, 85°, 42°, 0°), and the Zeiss Movikon (16 mm) a similar shutter with five settings (180°, 90°, 45°, 20°, 0°). In the 16 mm field only the Berndt-Maurer 16-Pro and 16 Sound-Pro cameras have complete, automatic dissolving shutters, and these are custom-built instruments selling above $5,000 and hence only of goggle-eyed interest to most amateur movie makers.

The dissolving shutter was originally designed for the production of smooth fade-ins and fade-outs, and takes its name from the simple elaboration of these—the simultaneous fade-out of one scene and fade-in of another—the lap dissolve. Of course this refinement requires a back-winding of the fade-out film while the shutter is closed, followed by a fade-in of the new scene on the same length of film stock. These tricks are not only old stuff to the professional motion picture cameraman but ones he seldom uses in the studio. Only when scenes have to be shot in sequence by a single camera, and will receive little cutting in the editing room, are fades and lap dissolves worth the bother. These requirements are met more often by the amateur than by the tyro, who relies upon the optical printer to assemble expertly on the master negative not only the shots from the various cameras but all desired special effects—lap dissolves among them.

In professional hands the dissolving shutter is used more for four other types of work. Where a change is to occur during a shot, from normal camera speed to slow motion, a compensation in exposure must be made. The very rapidly moving shutter must admit as much light

* From Johnson Foundation, University of Pennsylvania. Received for publication April 1, 1944.



Polaroid dissolving shutter attached to 1 inch lens in taking position on 16mm Bolex camera. Note split adapter rings surrounding lens hood, and reflection of cable release in both surfaces of each Polaroid disc. Polaroids crossed 8°.

to the film as when rotating at normal speed. The cameraman sets the lens iris diaphragm for the exposure yielded by his shutter full open at top speed. He then closes down the shutter to admit the proper amount of light at the slower shutter speed. At the same time in the shot when his assistant steps up the camera speed for slow motion, he

engages the drive on the dissolving shutter, causing it to open automatically to full aperture. Thus both normal and slow motion shots are correctly exposed and there has been no alteration in lens setting, hence in depth of field. This trick requires a knowledge of shutter setting in relation to camera speed.

A second use is in following an action from bright light to poorer illumination, for which the iris is set again to match the shade condition, and the shutter closed to meet the bright light requirements. As the action moves from sun to shade, the dissolving shutter is engaged and exposure is compensated for. This requires a knowledge of shutter setting in relation to lens aperture. Tables showing the effect of shutter opening with respect to both camera speed and lens aperture are available to all in the American Cinematographer Hand Book and Reference Guide (4th edition, 1942; edited by J. J. Rose; American Society of Cinematographers, Hollywood, Cal.)

It will be seen from the above that the dissolving shutter can be used also in place of a neutral density filter, with the advantage of being extremely variable in "density." This is probably its most common use in professional cinematography. With camera speed and film type decided on, the illumination conditions over sand, snow, water and the like are often too bright for control with an iris diaphragm closing only to f.11 or f.16. Such settings, moreover, may bring into sharp focus background details which the cameraman wishes to subordinate. Then set the iris according to the requirements of the subject matter, and manually close down the shutter to bring the exposure to the correct value for the chosen film. Thus the number of frames per second and the lens setting are retained, but the actual exposure of each frame is shortened until the film is receiving the correct amount of light.

Finally, in animation work, the same frame of film may be exposed as often as a dozen times, or only once. Each frame must have the same total exposure as the one which preceded it and the one to follow. It is something like a multiple lap dissolve, and all the ingredients must be correctly apportioned or the total will not be correct. For this the dissolving shutter is usually operated manually and set at values corresponding to definite proportions of total exposure.

It was for animation work that the writer obtained a Bolex H-16 camera and built a dissolving shutter. Since the device he designed and constructed may be used on any camera, 35 mm or 16 mm or 8 mm movie or still, with useful results, the details of structure will be of general interest. Some of the essential parts were purchased with a grant-in-aid from the Carnegie Corporation of New York, for which grateful acknowledgement is made.

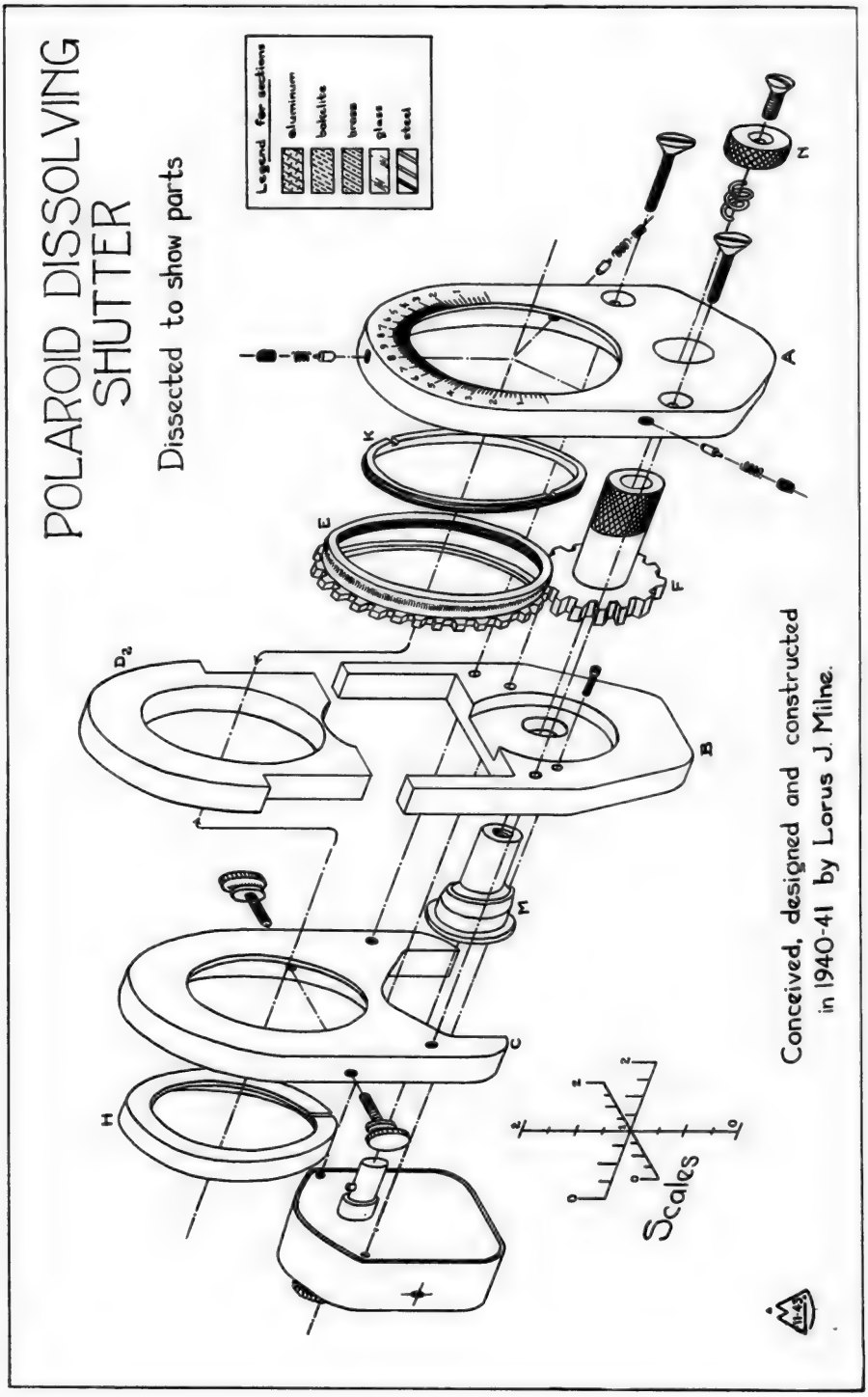
The basic elements of the shutter are two discs of Polaroid H in optical B-glass, and a clockwork motor for the automatic drive mechanism. Through the courtesy of the Polaroid Corporation of Cambridge, Mass., the writer was able to use the excellent Polaroid H material before it was placed on the general market. The motor was taken from a Baia Cine-Transito, Jr., and has the characteristic of rotating a spindle through 180° in 2½ seconds and then stopping; it is actuated by a short cable release. During the 2½ seconds, a known number of frames are exposed at any given camera speed, e.g., 40 (one foot of film) at "silent" speed.

The metal and bakelite housing and drive parts were machined on a home workshop lathe having a milling attachment. A dividing fixture from "Popular Science" magazine and a fly cutter with carefully ground tool bit produced the gears needed and also allowed the indexing of the face plate. The gears have teeth of approximately involute spur form. 24 diametral pitch. The following stock was used:

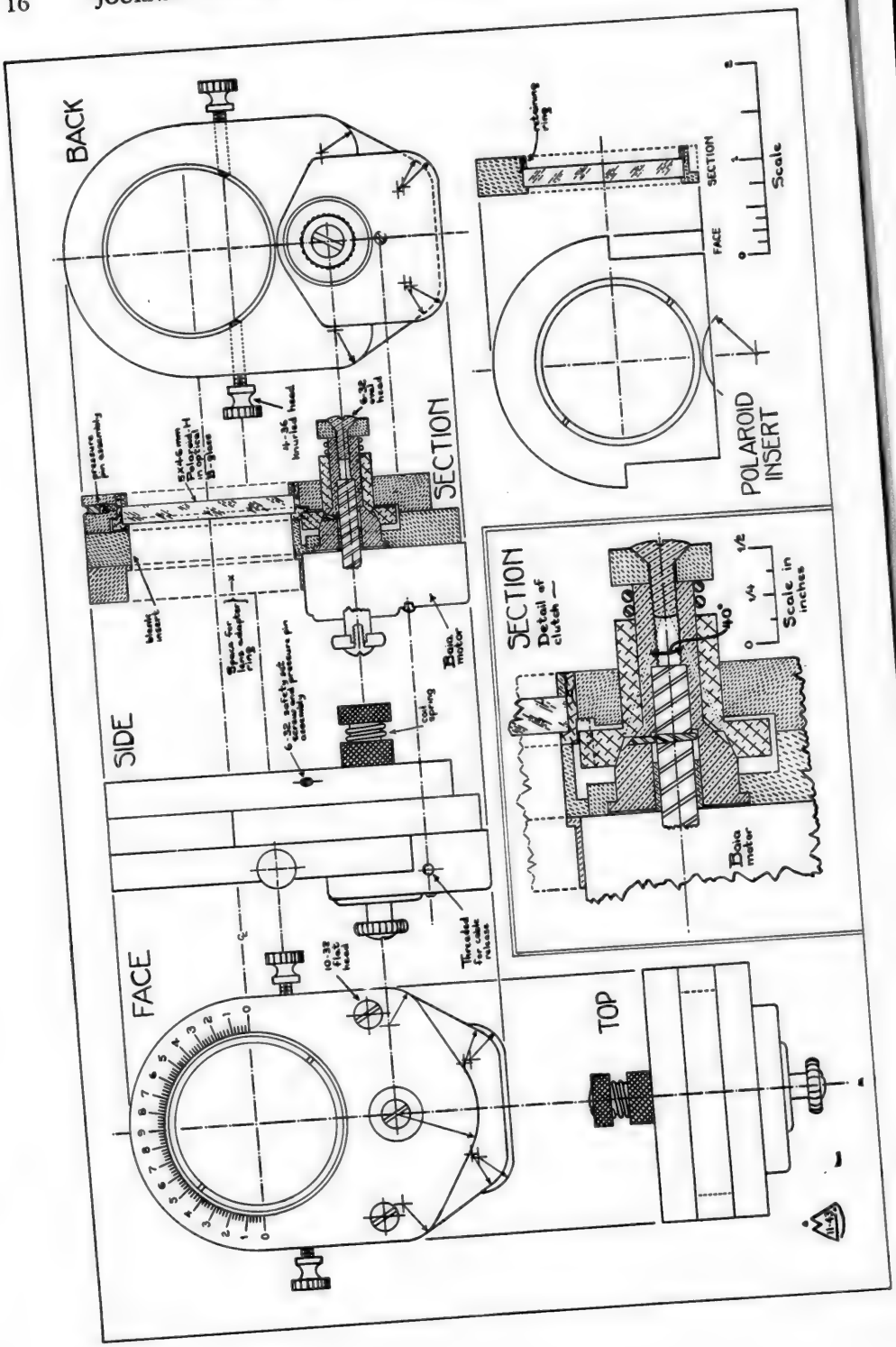
⅜" black bakelite sheet 2¾" wide, pieces of length 2½ (need 2), 2¾", 3¼", 3¾"
½" black bakelite rod ⅜" long
⅜" cast aluminum plate 2½" square
1⅛" cast aluminum rod 3" long
1" brass rod 2" long
½" x 2¾" bronze tube 4" long
0.050" steel music wire for spring, 2" long
phosphor bronze coil springs and tumblers 3/32 x 3/16" from Yale cylinder locks, 3 each
10-32 brass flat head screws, 1" long, need 2
6-32 brass oval head screw ½" long, need 1
6-32 safety set screws ¼" long, need 3
4-36 brass knurled head screws 1" long, need 2
3-56 brass fillister head screws ½" long, need 2
#0 steel taper pins, need 2

The aluminum was old waffle iron grids melted down in an open ladle in a forge, and cast in damp sand. Wooden patterns were used, ½" larger in each dimension than the finished casting wanted. The rough castings were machined to size and the chips saved for remelting and future use. The castings are remarkably fine grained and free from pinholes and pits.

Following the lettering of the accompanying dissected view, the sheet bakelite was cut into pieces A, B, C, D_1 and D_2, the rod bakelite into piece N, the aluminum plate into gear ring E, the rod aluminum into F, the brass rod into clutch piece M, the bronze tube into adapter rings G_1, G_2, G_3 and H and the two retaining rings K and L. The


POLAROID DISSOLVING SHUTTER
Dissected to show parts
Legend for sections
aluminum
bakelite
brass
glass
steel
A
B
C
D2
E
F
H
K
M
N
Scales
Conceived, designed and constructed in 1940-41 by Lorus J. Milne.

Polaroid discs were placed in D_1 and E and held firmly by the threaded retaining rings L and K respectively. A-B-C is a sandwich, held together by the 10-32 screws countersunk flush into plate A, tightened in tapped holes in C. The outer face of A is scored as shown, at two degree intervals for 180°. Every fifth score line is longer and has a stamped number, 0 to 9 to 0 to represent 0° to 90° to 0° in steps of ten degrees. Into the larger recess in the back face of A, gear E is held by the three Yale tumblers pressed into the positioning groove on E, the pressure regulated by the tension under which the three Yale tumbler springs are kept by the 6-32 safety set screws which back them. (If safety set screws had not been easily available, plain 6-32 screws could have been beheaded and a fine saw cut made across the outer end to take a small screwdriver when they are below the surface of the edge of plate A.) Into the smaller recess in the back of A, fits gear F, meshing with gear E, the knurled end of F projecting from plate A. Gear F revolves on the clutch piece M as shown in section, hence on the spindle of the spring motor. F may be rotated manually, or when the clutch is engaged, driven from the motor. Since gear F has half as many teeth as gear E, the 180° rotation of the motor spindle carries gear E through 90° in 2½ seconds, turning the Polaroid axes from parallel to crossed, or vice versa. A notch in the margin of E is used as an index to check the position of the Polaroid axis in the rotating plate. Plate B is recessed to provide space for gear F, since its teeth are twice as wide as those of gear E, so as to continue to mesh when pulled forward for adjustment of the clutch mechanism. To the opposite (back) face of B is screwed the motor housing with 3-56 screws, their heads in counterbored holes in B. Plate C is opened out to admit the sunshade of the largest lens with which the device is to be used—a 6½″ Taylor-Hobson-Cooke f.4.5 telephoto. For attachment to smaller lenses a series of nesting bronze rings G_1 to G_3 and H are used. Each is split so that pressure by the 4-36 clamp screws in plate C tightens the ring around the lens sunshade. G_1 is for a 3″ telephoto, G_1 plus G_2 for a 1″ lens, these plus G_3 for a ¾″ wide angle lens. H adapts the device to the lens barrel of the Argus C_2 and C_3 cameras (still). Plates D_1 and D_2 are interchangeable; the former carries the second Polaroid disc; the latter is blank. Both fit into the slot of plate B, between A and C. The coil spring of music wire compressed between knurled bakelite knob N and gear F presses F against the cone clutch surface of M. The angle of the cone (20°) is optimal for brass-aluminum. The taper pin in M engages the end of the taper pin in the shaft of the spring motor at one position to give a positive drive between the motor and M. A slight pull on F disengages the cone clutch and allows rotation of the Polaroid in E until the axes of the Polaroids are parallel at the same time as the taper pins are in the


BACK
SIDE
FACE
TOP
SECTION
POLAROID INSERT
SECTION
Detail of clutch
Scale in inches
Base motor
Threaded for cable release
10-32 flat head
6-32 knurled head
Base motor
FACE
SECTION
Scale

driving position. Without disturbing this clutch setting, more than 180° of freedom are available for manual positioning of the Polaroid in E.

For controlling reflections from shiny surfaces and water, or for enriching the blue of the sky in Kodachrome shots, the blank D_2 is used and the single Polaroid rotated manually to the position yielding the desired effect. This is done with the device held in the hand in front of the eye beside the camera lens. When set, the device is attached to the lens hood and the shot taken. It requires a three times increase in exposure.

For work requiring a single, slightly crossed position of the two Polaroids, the rotating member is set manually by turning the knurled end of F. Such is the procedure for using the device in multiple exposure work for animations, or for obtaining the neutral density filter effect in other photography. The correct setting is read from accompanying Table B in terms of the film employed. To combine the neutral density effect with the control of reflection or sky contrast, the Polaroids are crossed to the desired extent for exposure, and the whole device rotated into the position yielding the reflection or contrast control wanted, then being attached in this orientation to the lens hood.

For fades and lap dissolves, the clutch is engaged with taper pins in the driving position and the Polaroids with axes parallel. The scene is shot. When the effect is to be introduced, the cable release on the Baia motor drive is pressed, the Polaroid rotates through 90° and stops. If it is to be a lap dissolve, the camera is stopped immediately and the correct length of film rewound. Starting the camera and simultaneously again pressing the release on the motor drive, leads into the next scene with a perfect transition. Since the motor will operate more than half a dozen times on a single winding, little thought need be given to the device during a sequence.

For special effects such as increasing camera speed, the Polaroids are crossed to the necessary extent after the clutch has been engaged. For changes in which there must be an increase in light at the desired time (as with increase in camera speed for slow motion, or panning into shadows to follow an action), the taper pins are engaged in the driving position, the clutch cone slipped until the Polaroids are crossed (90°). The Polaroid is then rotated away from the driving position to the extent (X) which gives the neutral density effect corresponding to the greater light intensity. When the mechanism is released at the desired instant, the motor spindle and clutch will drive through the 90°—X° range, pick up the Polaroid and turn it to full open (0°). For changes in which there must be a decrease in light at the desired time (as with

TABLE A
New camera speed (lens aperture constant)

Old camera speed: frames per sec.	8	16	24	32	64
8	.....	0°–50°	0°–56°	0°–61°	0°–67°
16	50°–0°	.....	0°–47°	0°–50°	0°–56°
24	56°–0°	47°–0°	.....	0°–42°	0°–50°
32	61°–0°	50°–0°	42°–0°	.....	0°–47°
64	67°–0°	56°–0°	50°–0°	47°–0°	.....

Exposure equalizer for various camera speeds in terms of movement needed in Polaroid dissolving shutter.

decrease in camera speed, or panning into bright sun from shadows to follow an action), the taper pins are engaged, the clutch cone slipped until the Polaroid passes the 0° position and continues on to the position 90°—Y°. The Polaroid is then rotated away from the driving position to full open (0°). When the mechanism is released, it will drive through the 0°—(90°—Y°) range, pick up the Polaroid and turn it to Y° as wanted. For both these uses, the motor drive should be actuated slightly before the change in light requirements occurs so that the slack will be taken up and the rotation of the Polaroid take place at the second needed. Naturally it is best if the cameraman can rehearse this a few times before shooting film, so as to get from the action a cue for his thumb on the cable release.

With axes parallel, two discs of Polaroid H require an exposure of two full stops extra, i.e., a filter factor of 4. The single Polaroid has a factor of 3, hence the lens must be opened 1½ stops. With axes crossed at 90°, bright sun on white paper at f.1.5 does not affect high speed pan film at 16 frames per second. The relations between degrees of crossing, camera speed departures from normal and iris settings from normal, are given in the accompanying tables. For comparison, the conventional angular aperture settings of a professional dissolving shutter are shown in the same tables.

For lap dissolves and for animation, it is necessary to know the latitude of the film used. Individual tables must be worked out for animation, to show proportions of total exposure. With axes parallel, various lens settings are tried under the standardized lighting conditions. After standard processing of the selected film, the best value of exposure is selected — it might be f.6.3 at 1/30 sec. Then with axes parallel and lens setting f.6.3. and 1/30 second exposure, a strip of film is shot frame by frame, followed by a single blank (a black card held in front of the

camera), then a series in which after each frame is shot the axes are crossed one degree more. Finally with axes at 90° to one another, a strip of film for a trailer is run through the gate. When this test length

TABLE B

Equivalent stops closed		2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Filter factor		4X	5.6X	8X	11X	16X	22X	32X	45X	64X	90X	128X	180X	256X	360X	512X
2 Polaroids crossed		0°	35°	50°	56°	60°	67°	71°	74°	77°	79°	81°	82°	83°	84°	85°
f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.	f.
32.0	18.0	16.0	12.5	11.0	9.1	8.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4
25.0	16.0	12.5	11.0	9.1	8.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4	
22.0	12.5	11.0	9.1	8.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4		
18.0	11.0	9.1	8.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4			
16.0	9.1	8.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4				
12.5	8.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4					
11.0	6.3	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4						
9.1	5.6	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4							
8.0	4.5	4.0	3.5	2.8	2.3	2.0	1.8	1.4								
6.3	4.0	3.5	2.8	2.3	2.0	1.8	1.4									
5.6	3.5	2.8	2.3	2.0	1.8	1.4										
4.5	2.8	2.3	2.0	1.8	1.4											
4.0	2.3	2.0	1.8	1.4												
3.5	2.0	1.8	1.4													
2.8	1.8	1.4														
2.3	1.4															

Exposure equalizer for various Polaroid angles (camera speed constant)

no Pola	one Pola	0°	35°	50°	56°	60°	67°	71°	74°	77°	79°	81°	82°	83°	84°	85°
270°	90°	72°	42°	32°	22°	18°	13°	8°	....	....	....	.....	.....	.....	.....	.....

Note: Lowest row indicates corresponding angular apertures of professional 270° dissolving shutter.

has been processed, it is easy to decide which was the last frame on which anything shows to indicate exposure. Counting back from this to the blank frame at the beginning of the fading series, there may be say 56 frames of gradually increased exposure up to that value selected as best, viz. axes parallel, f.6.3 at 1/30 second. Plot a graph with degrees of crossing from 0° to 56° on one side, exposure from 0% to 100% on the other. Rule a straight line from 56° and 0% to 0° and 100%. From this graph any desired percentage of total exposure may be read off in terms of degrees of crossing. Such a graph will be good for only one film, one color temperature of light, one processing procedure, but in animation work where these are all kept constant, the one graph is sufficient and commonly used values may be tabled for convenience. For other work, the 56° extinction point should be looked up on the

TABLE C

Lens setting behind dissolving shutter (camera speed constant)

"Normal" lens setting	f.	1.4	1.8	2.0	2.3	2.8	3.5	4.0	4.5	5.6	6.3	8.0	9.1	11.0	12.5	16.0
	32.0	85°	84°	83°	82°	81°	79°	77°	74°	71°	67°	60°	56°	50°	35°	0°
	25.0	84°	83°	82°	81°	79°	77°	74°	71°	67°	60°	56°	50°	35°	0°	
	22.0	83°	82°	81°	79°	77°	74°	71°	67°	60°	56°	50°	35°	0°		
	18.0	82°	81°	79°	77°	74°	71°	67°	60°	56°	50°	35°	0°			
	16.0	81°	79°	77°	74°	71°	67°	60°	56°	50°	35°	0°				
	12.5	79°	77°	74°	71°	67°	60°	56°	50°	35°	0°					
	11.0	77°	74°	71°	67°	60°	56°	50°	35°	0°						
	9.1	74°	71°	67°	60°	56°	50°	35°	0°							
	8.0	71°	67°	60°	56°	50°	35°	0°								
	6.3	67°	60°	56°	50°	35°	0°									
	5.6	60°	56°	50°	35°	0°										
	4.5	56°	50°	35°	0°											
	4.0	50°	35°	0°												
	3.5	35°	0°													
	2.8	0°														

Equivalent exposures for various settings of lens behind shutter

accompanying Table B. It will be seen to correspond to an exposure reduction such as would be given by a neutral density filter of 11X, or a closure of the iris diaphragm through 3½ stops, i.e., to f.22 from f.6.3. It is easy to investigate each type of film used and ascertain its latitude for both daylight and artificial light in terms of number of stops between good exposure and extinction. This value will be independent of lighting conditions other than color temperature. From these data it will be seen that in a lap dissolve the zero point of exposure is reached for this film at 56° and corresponds to the length of film passing the gate in 56/90 of 2½ seconds or 1.55 seconds, i.e., 56/90 of 40 frames at 16 frames per second, or 25 frames. Hence the backwind for a lap dissolve with this film should be 25 frames (not a foot), and a fade at 16 frames per second will be 25 frames long.

Thus the device described yields the same effects as a built-in dissolving shutter, and adds considerably to the versatility of any movie camera. It will fit 8 mm or 16 mm or 35 mm cameras equally well and makes an automatic and manually controllable dissolving shutter available for the entire amateur field. It can serve either as a dissolving shutter or a Pola-screen or both. Since it uses Polaroid H material rather than the commonly available J material, its color neutrality is very much better and its extinction much more complete. The device is compact and light in weight (9.5 ounces with both Polaroids in place, with cable release but without adapter rings). With care even the aluminum and bronze could be replaced by bakelite, producing a lighter though somewhat less durable part. It can be employed as an excellent pola-screen for any still camera which the movie maker may carry with him. And the device can be built inexpensively by anyone who has access to a small lathe; in its construction, shop experience is unnecessary—the writer had had none.

Photography in the Autopsy Room

by William F. Payne*

ONE of the uses of photography about which little has been written, is photography in the autopsy room. In considering this subject, it is a well known fact that much valuable material and many specimens which are pertinent in the study of the case are never photographed. There have been a number of requests for a paper on this subject from time to time, yet few articles have been published. Hence, if for no other reason, this paper is written. Perhaps it will create a stimulus for others to write on the subject and be the beginning of a series of papers which will be instrumental in improving technic and equipment which are now in use. This manuscript will not discuss the photography of specimens after they have been removed but will include all the photographic procedures necessary in the autopsy room.

In the general hospital, research institutions and the medical examiner's office, autopsies are of utmost importance. In the case of the medical examiner whose functions are judicial as well as investigative the cause of death is frequently determined by autopsy. The distinction between murder, manslaughter or suicide often depends on the findings at necropsy. The result of medical treatment is generally proven in experiments on animals by autopsy. Without the cow, smallpox never would have been prevented; without the dog, victims of diabetes would be expiring soon after symptoms developed. From necropsy clinicians have learned the results of too much treatment or inadequate treatment.

Color emulsions have demonstrated xray reactions at different depths as well as the degree of reactions on the skin. Color photography has been a big step forward in recording conditions of wounds or any condition in which the color is important in diagnosis and treatment but even with the recent advances in color emulsions there are still many uses for monochromatic films, better known as black and white.

The appearance of malignant growths and their relation to the surrounding parts would never be appreciated if photographs were made after the organ had been removed from the body. Photographs of a collapsed lung compared with the other lung, a dilated ureter compared with the ureter not affected, a malignant growth in the gastro-intestinal tract as well as abdominal adhesions should be included as a definite part of any medical records.

In cases of death caused by bullets or sharp instruments, the path of the missile or the direction of the knife wound can be better shown

* From the State Institute for the Study of Malignant Disease and the Scientific Staff of the Buffalo Police Department, Buffalo, N.Y. Received for publication August 1, 1944.

while the victim is still on the autopsy table. The resulting photographs are submitted later on, to the grand jury who determines a "Bill" or "no Bill". These juries are generally composed of lay people whose knowledge of anatomy is very limited. Thus, good photographs will afford a better conception of the factors involved in a case than the evidence the medical examiner tries to explain. The path of the bullet must be carefully traced or the problem of locating it may take hours.

For example, a female, age 23, was found dead in her home. Upon examination a small .22 caliber bullet wound was found in the axillary line on the right side, entering the space between the third and fourth rib. With the aid of a metal probe the bullet was traced through the upper lobe of the right lung, severing the thoracic aorta causing instant death. For two hours the search continued but no bullet could be found. There were no indications to show that the bullet had left the body. The body was closed and sent to the xray department of a local hospital. Radiographic examination of the entire thoracic cavity did not reveal the bullet. The bullet was finally found at the level of the middle third of the left humerus, having followed a very irregular course. In other words, the bullet had entered the right side, severed the thoracic aorta, followed the contour of the ribs and finally ended in the opposite left arm, half way down to the elbow. This bullet was the only evidence to prove that it was murder and not suicide.

Later, a revolver was found in the possession of the murderer and with the aid of the comparison microscope it proved to be the gun from which the bullet was fired that caused the woman's death. This of course was an unusual case but there are those that feel that if this bullet had not been found the criminal would never have been apprehended. A trace-back of the path taken by the bullet then was photographed in motion pictures. These cinemaphotographs demonstrated clearly to the jury the unusual course taken by the bullet.

In another case a negress, age 31 weighing 250 pounds, was stabbed by a negress, age 21 weighing 115 pounds. The weapon in this case was an ice pick. The victim was stabbed six times following a quarrel over a twenty-five cent lock. The resulting photographs, taken at the scene of the crime gave one the impression that all six stab wounds were superficial, yet one of them no larger than the rest, showed upon opening the body of the victim and subsequently by photography that the ice pick penetrated the pericardium and punctured the heart causing death. The difference in the weight of these two women became an important factor later on in the prosecution of the case.

In order to register a photographic image on a film, light is necessary. High intensity lights and flash bulbs are frequently used to shorten the exposure time. Obviously, color filters which are necessary

especially when panchromatic films are used, add to the exposure time, which together with a small diaphragm stop necessitate exposures of several minutes. With flash bulbs and high intensity lights, conflicting reflections often result. To eliminate these reflections polarized light may be used. There is no doubt that polarized light will improve photographs taken in the autopsy room because it is possible to make pictures of fresh specimens without the annoying or conflicting reflections. Of course one must bear in mind that with polarized light, Wratten filters and small stops, the exposure time must be increased by about six times.

There are three ways of producing polarized light. One by reflection, the second by the nichol prism and the third by polaroid, photographically known as pola screens. From a practical stand point pola screens are the answer. The vibration of light waves are not along the direction of the ray, as in sound, but are at right angles to the ray and usually in all possible directions, that is, up, down and sideways.

It is possible by various devices to change the light ray so that it vibrates in only one direction. The credit for this polarizing material is due to Edwin H. Land, who was the first to prepare a practical, commercial sheet containing a polarizing material. In this material there are countless rod-like crystals, which are parallel to each other. They may be regarded as optical slits so that when the polaroid is rotated, the direction of light vibration is rotated. In this way all light passing through the pola screen which is used in front of the source of illumination, is polarized to a certain plane. The pola screen does only this.

In order to control the angle of polarization a second pola screen is placed over the camera lens. In this way it is possible to rotate the pola screen over the lens until the reflections that are objectionable disappear. The pola screen mounted over the lens is held in place by a lens hood which aids in shielding it from the incandescent light. This lens hood is attached to the photographic lens. With the aid of two wire loops, which are attached to the lens hood, two strings tied to the pola screen, make it possible for the photographer to rotate the pola screen 90° and still observe the effect of this rotation while looking through the ground glass at the back of the camera, even with the bellows extended 24 to 36 inches. Pola screens have a spectral range of polarizing power from 400 *mu* to 700 *mu*. They absorb in the ultra violet and transmit light quite freely, without polarization. The pola screens can be damaged by excessive heat. Thus care must be exercised not to place the pola screen too close to the light source.

There are two types of pola screens on the commercial market today, Type I and Type II. Type II is to be used over the source of illumination and all light striking the object to be photographed must pass

through this screen. This will necessitate a shield so arranged that it will cut off all the light with the exception of that passing through the pola screen. However this type II pola screen has its limitation and can be used only when the screen is properly placed in front of the light. It will cause the angle of polarization to be 90°. If for some reason 90° solves the problem, then only type II screen is necessary.

A type I pola screen is necessary if the simple pola screen does not accomplish elimination of objectionable reflections. This pola screen is placed over the photographic lens and is rotated to the left and then to the right until all reflections are removed from the object to be photographed. All extrinsic light in the autopsy room must be shielded in such a manner that no light strikes the object. Light proof curtains will solve this problem.

LIGHTS

For black and white movies or stills, photoflood lamps are recommended. There are three types of these lamps on the market today. Number 1 develops 8650 lumens; Number 2 develops 17,000 lumens; and Number 4 develops 33,500 lumens. When burned at 110-120 volts they are overloaded causing their life to be shortened. The amount of ampheres they draw while in operation, permits them to be used on any house circuit. For Kodachrome color films the photofloods can be used as well on 35 mm and Number 828 films. If professional type B Kodachrome is used there is but one choice of illumination, which is light having a temperature of 3200° Kelvin. A 120 volt 500 watt lamp is preferred by the author but one must always ascertain whether the necessary 120 volts are present. If not then compensating filters are recommended that will balance the light so that the color temperature is 3200°. Balancing the temperature of the light source is most important.

There is a choice of two motion picture films in the 16 mm size: color type A and the black and white. The author prefers the Eastman Super XX Panchromatic film. Speed is important as the exposure is increased about six times when both pola screens are used. It will be quite impossible to judge exposure stops with a light meter when using pola screens. However the pola screen holders contain a scale of from 1 to 8. With the aid of test exposures, one can readily record the proper stop once the graduation from 1 to 8 has been determined. When using this graduated scale, lights used to illuminate your subject must always be of the same wattage and at the same distance from the subject.

CAMERAS

The type camera will depend upon the equipment at hand, for almost any kind of camera may be used for photography in the autopsy

room. For those who may be interested, the following has proven satisfactory to the author. The Eastman Clinical camera, 5 x 7 size with an anastigmat f.7.7 with 203 mm focal length is used for stills. This camera has a focusing hood on the back which is more convenient to use than the focusing cloth. The Eastman Recomar Number 33 camera with the Bantam back attachment is used for still photography in Kodachrome. With this camera a 3¼ x 4¼ film can be used which is nearest to the standard lantern slide. With the Bantam back attachment Number 828 Kodachrome films can be used for those who prefer the 2 x 2 slide size permitting five exposures to be made for the price of one 3¼ x 4¼ film. Another advantage of the Bantam back attachment is the ground glass which will eliminate poor focusing as well as poor composition. The standard thumb screw on the tripod will fit both cameras allowing them to be interchanged quickly and easily.

There is a wide selection of cameras. In most institutions some member of the staff owns a 16 mm camera which will serve most purposes very well. If a choice of cameras can be made, the Cine Kodak Special has no equal. With this camera the question of focusing and composition is eliminated by the reflex finder. With this reflex finder it is possible to observe the result of rotating the pola screen until the desired effect is obtained. The speed with which one can change from a magazine containing black and white film to a magazine containing color film is a definite convenience. There is sound speed available and the sound may be dubbed in at a later date for teaching purposes. Two lenses are used although a third is always carried. The one principally used is the f.1.9 with a focal length of 25 mm. For close-ups of the same field a f.2.7, 2½ inch telephoto will prove valuable. The third lens listed is a f.2.7, 15 mm wide angle lens which will cover a large area not possible with the other two lenses, such as when a photograph of the whole body is desired.

Camera Tripod

One of the most important pieces of equipment essential for successful photography in the autopsy room. The pathologist or medical examiner would like to have pictures which show what he sees. In order to approximate his view the camera is moved up and over his right shoulder. All that is necessary is to have the pathologist prepare the object for photography, step aside and the rest is done by the photographer. In order to get the camera up and over his shoulder it would seem that a tall tripod is necessary. Such a tripod has proven impracticable as it generally means that the camera is too high necessitating the photographer to be atop a step ladder. There is always the possibility of the photographer falling during the process of focusing or making

the exposure. Again there is the necessity of going up and down the ladder to insert the film holder and descend again to make the exposure.

In order to speed up the actual picture taking a tripod was made by the instrument-maker of the State Institute, whereby the photographer was able to manipulate the equipment while atop the tripod. The tripod was made from a discarded bed-side table taken from one of the rooms in the hospital. It is in two sections which permits transportation to and from the operating room, where it can also be used and when taken apart it will fit in the back seat of any sedan. The bottom section is the bed-side table itself, figure 1. It is 36 inches high and 20 inches square. It has large spacious cupboard in which all the necessary photographic equipment is kept. In transporting this tripod from one room to the other the entire stand is easily moved by four large casters which can be locked in place when and where rigidity is of paramount importance.

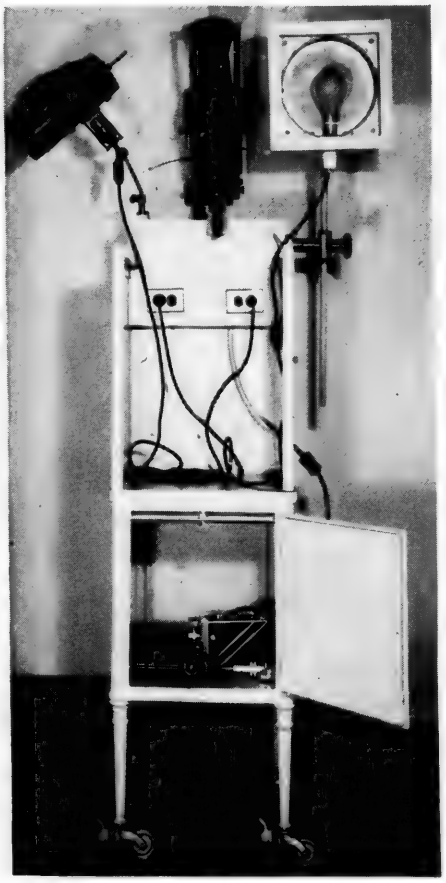


Figure 1

The back view of the tripod is shown in figure 1. The lights are turned backward to show their relative position on the tripod. On the right is the single illuminating unit for general illumination. Note that the entire reflector is enclosed, allowing all of the light to be transmitted through the pola screen. The pola screen has been removed in order to show the arrangement of illuminating unit. The light can be tilted to any degree to illuminate the detail which the pathologist or medical examiner wishes to show. Lateral tilts are accomplished with the supporting arm and the tripod head. The camera is in the center of the tripod and is mounted on a tilt top which is attached to an arm which can be elevated or lowered as needed.

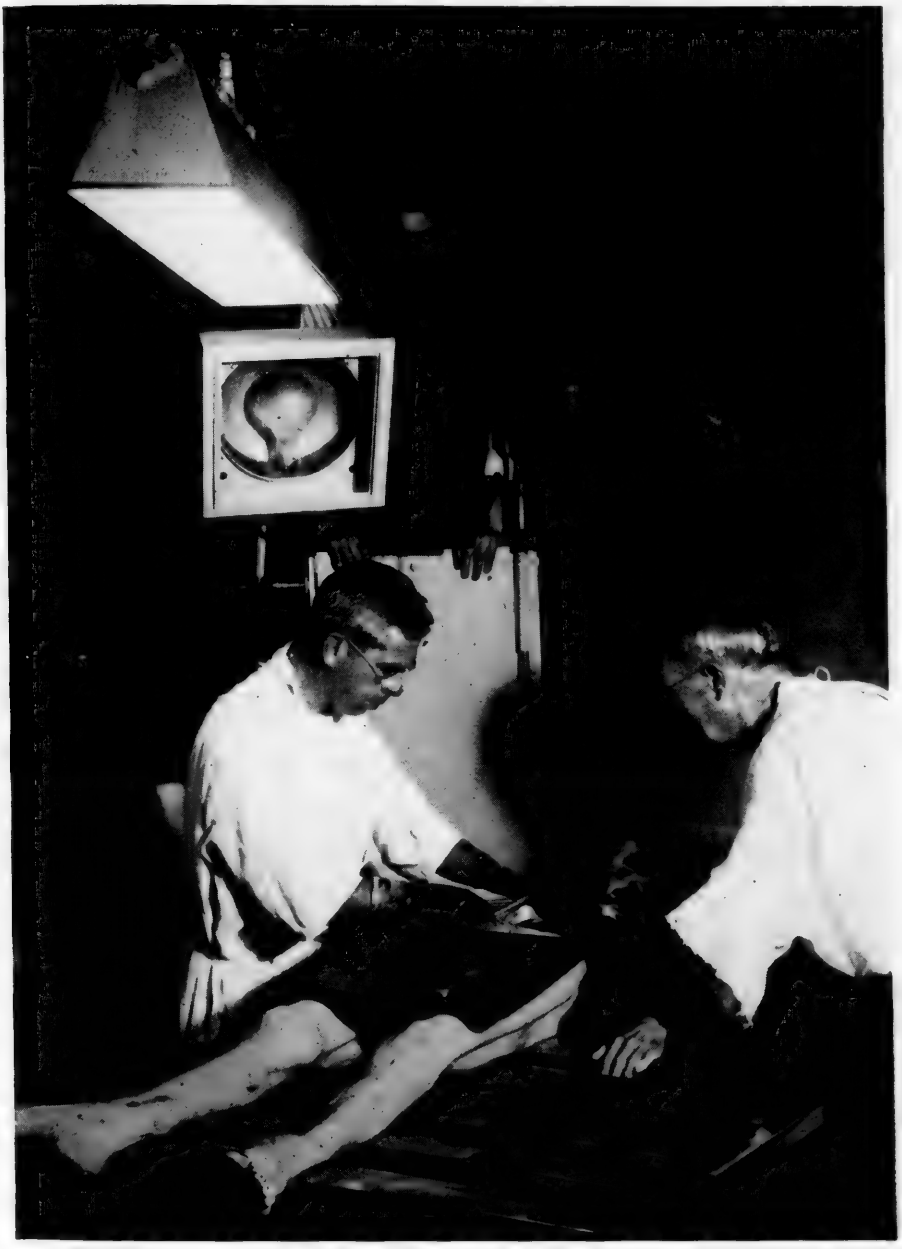


Figure 2

On the left side of the tripod is a spot light containing a 1500 watt bulb and a 6 inch and 17 inch focal length condenser. This spot light is used for focusing the object on the ground glass while the

other light is used for making the actual exposure. This helps to reduce the amount of heat that would develop from the photoflood bulb if it is used for both focusing and exposing the photographic film. The spot light is used also as an auxiliary light for making motion picture, especially when the pathologist is working inside the body. However, it must be kept in mind that if this spot light is used for focusing and exposing the film, another Type II pola screen must be used in front of it.

All lights are controlled from atop the tripod which facilitates ease of operation as well as adaptability to any problem that may occur while atop the tripod. The sides of the tripod are made of sheet iron 1 mm thick attached to an angle iron frame which acts as a seat for the photographer while waiting for the pathologist to prepare the specimen.

On the inner side, near the top of the tripod there are four base plugs from which electric current can be supplied to all electric units for this type of photography. The two additional outlets are used to connect a blower for cooling the pola screens and for a flash bulb reflector or any other auxiliary equipment necessary. On the right side, outside the tripod itself there is a male electric outlet which is easily connected to any electric source, and allows but a single cord on the floor while working. An extension cord thirty feet long is stored in the cupboard for this purpose.

Figure 2 gives a general view of the set up in operation. Note how little space the tripod takes up and how the pathologist and other members of the staff have more than sufficient room to work and observe.

PRINTS

In hospitals, glossy 5 x 7 prints seem to be preferred. Exposures on smaller films are enlarged to 5 x 7. The print is mounted on an 8½ x 11 sheet of paper because it fits into the patient's chart where all photographs pertaining to the case are kept. In the Buffalo Police Department 8 x 10 prints are preferred. Eight copies are made from each negative. Each of the following receive one print: homicide squad, Chief of Detectives, medical examiner, District Attorney, grand jury and the police photographer. An extra copy is made for the photographer's file.

SUMMARY

Photographs in the autopsy room can be made easily. Polarized light is recommended principally because it eliminates objectionable reflections. Photographs taken in the autopsy room are of definite value in the disposition of any case. Recognition is hereby acknowledged to Mr. Ernest Trapp, instrument maker at the State Institute for the Study of Malignant Disease, for his most valuable assistance in making the equipment described above.

Certain Problems in Zoo Photography

by
S. C. Dunton*

IT is not the purpose of this paper to discuss all of the manifold phases of zoo photography, for this would require much more space than has been allotted for this particular article, but rather to cite a few typical problems often encountered in this type of work and to show how these specific problems may be worked out to a satisfactory conclusion. The photographs that accompany the text are self-explanatory and no further reference will be made to them, although they illustrate the various points considered herein.

There are three major factors in the photography of animals generally found in the collections of zoological parks, and they are listed below in the order of their relative importance.

1—Choice of backgrounds

2—Lighting

3—Characteristics of the animals

These three factors are always present and in many instances are inter-related to such a degree that it is impossible to consider one without treating the others.

It is the author's feeling that the choice of background is a point of primary importance. Without the proper background, good lighting and good technic as well as skillful handling of the subjects avails but little. A good zoological picture should render as much detail as possible, and there should be a definite separation of subject from background to permit good reproduction when used for illustrative purposes. It is well-nigh impossible to retouch animal negatives or prints without obliterating some detail or altering body lines to some degree. As most animals exhibit protective coloration to some extent, the ideal background for photography is one which would rarely occur in nature. For our purposes, the background must contrast with the subject rather than blend with the animal as it would in nature. Furthermore, it should be kept as plain as possible so as not to detract from the central

* From the Staff photographer of the New York Zoological Park, Bronx Park, New York 60.
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object of interest. In the case of small animals, tame animals, or similar subjects that can be moved from their usual quarters and photographed under studio or semi-studio conditions this offers no great problem, but where the animals must be photographed in their own cages, iron bars, wire fences, tree trunks or heavy foliage, and visitors standing or passing by are often distracting elements that mar the picture no matter how much care is exercised in posing or lighting the subject. Visitors always tend to distract the subject no matter how tame the animal may be, and the author has found that the best results are obtained on days when the park has comparatively few visitors. There is little that can be done about objectionable objects such as fences, large trees, etc., but a telephoto or long focus lens used at a fairly wide aperture helps to throw such objects out of focus. Of these, however, the wire fence will remain evident long after other objects have faded out, and the fact that many zoological parks are striving more and more for the barless, fenceless, natural setting type of exhibition enclosure will do much to lighten the effort of zoo photographers and better their percentage of good zoological pictures.

In some situations it is possible to introduce an artificial backdrop or background, but this is applicable only where smaller animals are being photographed, and even then may make the subject nervous and excited. Sometimes it is possible to shoot from a low or high angle, outlining the subject against the ground or the sky, but with this method distortion must be guarded against for the most natural results are generally obtained by photographing from the level of the animal itself. Furthermore, when working from a high point to utilize the ground as a background, it is imperative that the ground contrast with the color of the subject. Another method of eliminating a poor background is to photograph the animal in direct sunlight while the back of the cage or enclosure remains in shadow. If the film is exposed for a normal reading on the animal the background will generally print out dark enough to subdue objectionable details. This is of course, applicable only to light colored animals.

It is rather generally known that if the lens of a camera be placed directly against a fence of fine or coarse mesh wire that the wire itself will be so far out of focus that it will not appear in the negative. It should be noted however, that this procedure is most effective at comparatively wide apertures and that the best results are obtained with a long focus lens. With a lens of short focus the image of the wire will begin to appear as soon as the lens is stopped down to any degree. The effect can best be observed with a ground glass camera. With a 17 inch lens stopped down no further than f.11, the camera may be held back from the wire a foot or two before any trace of the wire can

be seen. Where the subject is an animal or bird that can reach or strike with its claws or bill this is a distinct advantage to the operator!

While dealing with the subject of background it might also be proper to consider the use of props for posing the subjects in cage or studio photography. These should be kept as simple and as small as possible, but should be of some material that is in harmony with the subject. An old tree stump, several tree branches, and a few rocks of moderate size together with quantities of sand and dirt of various shades will be found very useful for the photography of small animals and birds. Tree stumps and branches should be well weathered and the presence of sharply cut ends should be avoided in the picture area.

The author relies heavily upon the use of synchronized flash for studio work and cage interiors. This type of lighting has the advantage of uniformity in volume and quality and is easily controlled. Movements of animals and birds, especially the latter, are quick and unpredictable and 1/200 second seems to be the safe minimum at which to work. It should be noted that this speed is especially indicated in the photography of birds at rest for their feathers present many small individual surfaces which must be rendered wiresharp to be technically good. A quick movement of the bird will blur these if less than 1/200 is used. Interiors of birds in flight can be handled only with a speedlamp operating at 1/30,000 second. The author generally uses two flashbulbs for the average small animal or bird portrait; one Press-40 at a 45° angle above and to the side of the camera, and one Press-O plus a spun glass diffuser close to and just above the camera for a front filler light. The average exposure with a light background is 1/200 second at f.22 on Super XX or with comparable speed film. With a dark background another Press-40 flash is used in a spotlight and this is placed above and to the rear of the subject to provide the necessary separation from the background. We do not use speedlamp equipment at the Bronx Zoo due to the present unavailability of such equipment, but its use seems highly desirable under studio or semi-studio conditions.

In regard to outdoor lighting there is little control possible aside from choosing the time of day most suitable for the angle of light desired. In the case of dark colored animals, or animals whose fur is apt to be wet such as Hippos, Sealions, Penguins, etc., a slightly overcast sky is preferable to direct sun, as with the latter light the contrasts and reflections from the wet coat of the animals are terrific.

Where the animals are sufficiently tame so that the operator may approach them reasonably close, it is often advantageous to supplement the daylight exposure with a flashbulb at camera position. Care must be taken, however, to keep the light from the flash secondary to the daylight, or a flat negative will result. Care must also be taken

Tiger Cubs. These c
were reared by M
Fred Martini, wife
the Lion House Keep
at the Bronx Zoo, b
cause their moth
would not nurse the
This picture was the r
sult of three hours
tensive work on the pa
of Mrs. Martini and h
photographer to g
them in the prope
pose, as they were
ternately very frisky
very tired. Picture w
made on Super XX
a 4 x 5 Speed Graphi
Exposure with 6½ in
lens stopped to f.
was 1/100 second wi
one Press 40 flas
about three feet abov
and to the left of th
camera. Cubs wer
posed on a studio cou
covered with a lig
blanket.

American Otter. Made out of doors under hazy sun wit
Speed Graphic equipped with 5¼ inch lens stopped to f. 16
Film used was Panatomic X and exposure was 1/200 secon
with a No. 2 Superflash used on the camera to provide th
necessary highlights in the dark fur. The Otter is a mo
difficult animal to photograph because of its rapid movemen
and dark fur.

Griffon Vulture "Old Nellie." Made on Ortho X cut film
a 4 x 5 Graflex, equipped with a 12 inch lens stopped to f. 1
Exposure in bright sun was 1/100 second. Background ke
in shadow to subdue unwanted detail. At the time th
photograph was made "Old Nellie" held the longevity reco
at the Bronx Zoo, her age being 41 years!

Hooded Sapajou. This little fellow was photographed in the studio with a Speed Graphic equipped with a 6½ inch lens which was stopped to f. 22. Film used was Super XX and two flash bulbs were used at 1/200 second.

aby Racoon. Made in studio with Speed Graphic camera on 4 x 5 per XX cut film. 6½ inch lens stopped to f. 22. One Press 40 ash for main light and one No. 0 flash for front filler light. Flash as synchronized with shutter at 1/200 second.

Young Lions. This picture was NOT made with a telephoto lens, et was shot from INSIDE the cage with a Speed Graphic equipped ith a 5¼ inch lens. XF Pan film was used and an exposure of /200 second was given with a No. 2 Superflash on the camera. laturally the keeper stood by while the shot was made.

that the animal is one which will not be alarmed by the flash both from the standpoint of subsequent pictures as well as the safety of the operator.

Some years ago in a paper on aquarium photography[1] the author pointed out that in such work it was essential that a person familiar with the habits of the specimens be consulted and stand by to do any handling required. This statement is equally true of zoo photography.

Those in charge of the animals know from long experience what the individual animal will or will not do, and to what extent it may be moved about for photographing. I have never known a keeper to be other than most cooperative in arranging the animal in the best possible position for photographing, as they themselves are usually interested in getting the best possible photographs of their charges. The author can testify from experience that animals are definitely individualists and there are no two alike. It is very necessary to respect their whims and the keeper's instructions should be followed implicitly. Serious accidents can, and have, happened to zoo photographers.

From the standpoint of camera equipment, the author believes that there is no universal camera for zoo photography. Probably the nearest to it is the minature camera of reflex type. The author has seen excellent results obtained with 35 mm cameras but these latter outfits require the ultimate in care both in operation and finishing to obtain really good results. No matter what camera is used a telephoto lens is almost a "must".

At the Bronx Zoo, most photography is done with Speed Graphic and Graflex cameras in the 4 x 5 size, with lenses varying from 5¼ to 17 inches in length. It has been found that one disadvantage of the Speed Graphic for zoo work is that with the normal length lenses it is not possible to get close enough to the bars or wire when photographing through the cage fronts, as the lens sets back rather far from the front of the camera. A camera of the Graphic type, which focused from the back rather than the front, would be most useful in this type of work.

In conclusion, it might be said that acceptable animal pictures may be made with any good camera, if due consideration is given to backgrounds, lighting, and the characteristics of the animals involved. Animals are much like children; they can seldom be driven but can often be coaxed into the proper position. Good animal pictures are sometimes "lucky" shots, but generally are obtained only after the expenditure of a considerable amount of time, understanding, and patience.

[1] Motion Picture Technique in Aquarium Photography. B.P.A. Journal, Vol. IV, No. 1.

35 mm Positive Transparencies

by

Russell Ingraham*

THE making of 35 mm positive transparencies is well within the reach of any serious minded photographic worker. There is a definite skill and technic required which differs from that used in making standard 3¼″ x 4″ glass slides. This article will deal with three possible ways of making 35 mm positive transparencies. The first method is to photograph on positive film directly from the original negative. The second method is to make contact positive prints from original 35 mm negatives. The third consists of making uniform paper prints to be copied onto 35 mm negative film and in turn printed on safety positive film.

The first method requires the use of a 35 mm double-frame camera which has provision for variable lens extension and critical ground glass focusing. This is a necessary feature because of the varying size of negatives to be copied and also to permit use of sections of the original negative. This method has its greatest advantage in producing slides of high quality when it is necessary to produce only a few 2″ x 2″ slides. However, it will require much additional time to obtain balanced slides from a large number of varying negatives. The chief disadvantage in working with this technic lies in the fact that positive film has its contrast, density and photographic quality controlled by varying the relationship between development and exposure. This factor makes the control of final projection quality more difficult than the use of 3¼″ x 4″ glass slides which come in varying emulsion contrasts.

The second method where contact positives are made is a logical one which has many difficulties in practice. The original negatives must be meticulously prepared. The frame should include only pertinent subject matter to eliminate distracting factors. Exposure and development control must be accurate to avoid the extremes which would be difficult to print on one grade of film. Contact printing is possible on many of the common low cost amateur printers. It will probably be necessary to add guides for the film and reduce the wattage of the printing lamp to a 7½-watt bulb or less. Since absolute contact over the entire picture area of the frame is essential, very thin masks must

* The Society for Visual Education, Inc. Presented at the Chicago Chapter of the Biological Photographic Association, December, 1943. Received for publication August 3, 1944.

be used. Such a mask can be made from the black paper which interleaves cut film in its original package. The opening should not reach into the film perforations but should be slightly larger than the mat area of the final slide.

Extreme care must be used to avoid dust and other particles between the negative and the positive film and between the negative and the printer glass. Much of the difficulty caused by dust can be avoided by carefully cleaning the negatives. The back of 35 mm film has no gelatine and may be cleaned with a solution of half alcohol and half water. This back should be wiped with a chamois dampened with the above solution. The chamois should not be so damp that drops of solution can be squeezed out of it. Dust on the emulsion side may be easily removed by carefully blowing or brushing with a camels hair brush. Foreign matter and fingerprints adhering to the emulsion should be removed by gentle rubbing with a chamois dampened with carbon tetrachloride. During these cleaning processes, the film should be stretched out on a clean felt covered board. This felt protects the film surface from scratches and also will absorb excess moisture which might get onto the face of the emulsion.

Method three involves the making of glossy prints or enlargements, preferably of one size and of uniform photographic quality, suitable for copying. The photograph of appropriate quality for copying should be a print or enlargement which is not quite as contrasty as the usual photograph. The shadows should have good detail and the highlights should have a definite veiling. This, however, does not mean a muddy print. The chief advantage of this method is the ease with which one may obtain balanced photographic quality in prints from negatives varying in size, density and contrast.

In copying the scale of reduction will be constant. A permanent setting of the copy camera may be maintained. Critical focusing must be done prior to loading the camera. A piece of fine grain ground glass is placed in the plane of the film. A magnifying glass of 10X or higher is strongly recommended. A better method is to make a simple lamp house to fit the back of the camera. Replace the ground glass with a fogged lantern slide plate in which a pattern has been scratched with a needle. The emulsion side of the plate should face the back of the camera lens. The beam of light projects this pattern onto a white card placed in the plane of the copy. Because of the magnified image, it is very easy to obtain critical focus. An outline of the binding mask scratched on the same fogged plate will give precise positioning for all copy.

There should be no white permitted on the copyboard. Prints should not have white margins. Dead black should extend at least

four inches beyond the *area* photographed. This dead black area is essential to eliminate stray light and halation effects which would reduce the crispness of the negatives, plug up shadow detail and otherwise spoil the photographic quality.

The common method for copy lighting of having two lights at a 45° angle is probably the best simple method of illumination. For copy up to 8 x 10 inches, the lights should be four feet from the center of the copyboard. The light source should be a pair of No. 1 photofloods in good reflectors of a type which do not give a hot spot. Aim each light so the center of illumination is directed to the side of the copy area farthest from that light.

The most practical method for obtaining proper exposure is to base the exposure on the manufacturer's recommendation for film speed, and

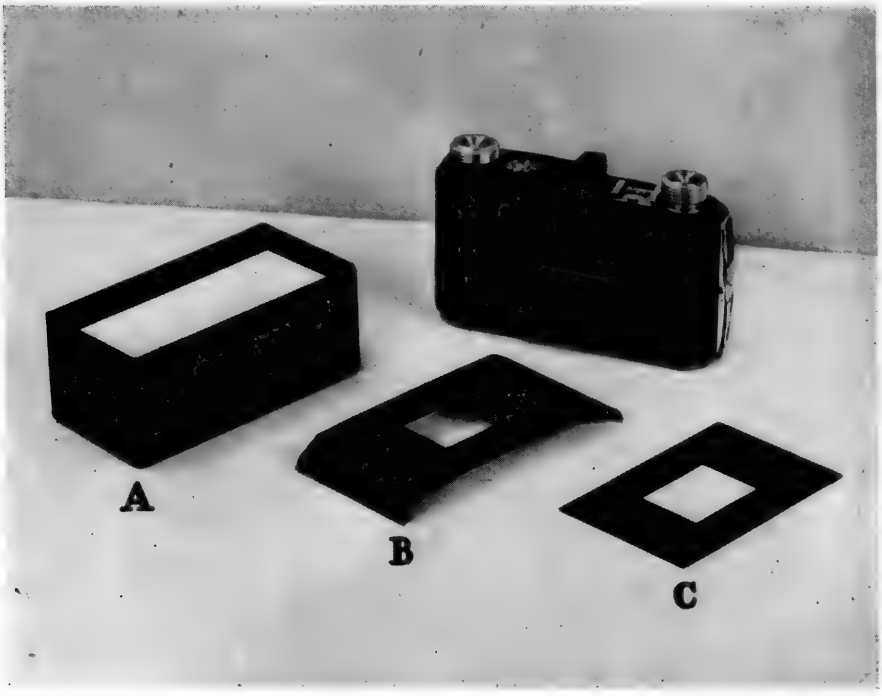


Figure 1

make a series of exposures ranging from ten times over to ten times under estimated normal exposure. For continuous tone copy a fine grain medium to slow panchromatic film is recommended. A tungsten light rating of 12 to 24 Weston is a satisfactory type. The developer should be fine grain of the Eastman D 76 or Agfa 17 type which does not

result in a brown image normally obtained with paraphenoldiamine. The development should be carefully conducted and timed so the same results can be obtained as needed. Development should be timed to achieve good gradation of all tones. For most work this is possible at a gamma of .8.

When most material to be copied is somewhat flat in gradation, it is advisable to increase the time of development of the copy negative.

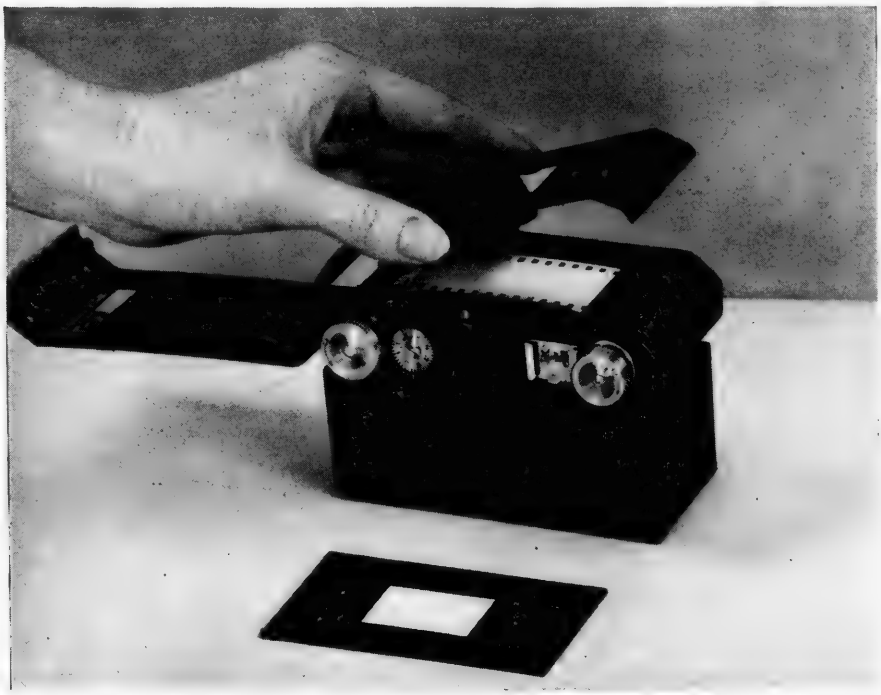


Figure 2

On the other hand, when the bulk of the material for copying is hard or contrasty, the developing time of the copy negative should be reduced. In adjusting for variation in developing time, the exposure is increased for shortened development and decreased for lengthened development. In the case of mixed copy, the best result is obtained by balancing the exposure of the individual frames to the center of interest of each frame. Normal development is then used. Negatives of line subject material may be made on positive film.

Before printing, the copy negative should be cleaned as indicated in method two.

Printing the positive transparencies has been one of the major difficulties in making 35mm slides. The preparation of special copy negatives as previously described is a fundamental factor in overcoming much of this difficulty. These negatives are used in a miniature film enlarger adjusted to work at a one to one ratio. The use of the projection method greatly reduces the dust problem because the film surfaces of both the negative and positive are easily accessible for dusting with a camel's hair brush. It is possible to remove dust specks at any time, even immediately before exposure. It will be found advisable to dust the working area with a damp lintless cloth immediately before printing. The negative carrier should be of the open dustless type rather than a glass sandwich. Extreme caution against abrasion should be observed. All light leaks should be eliminated.

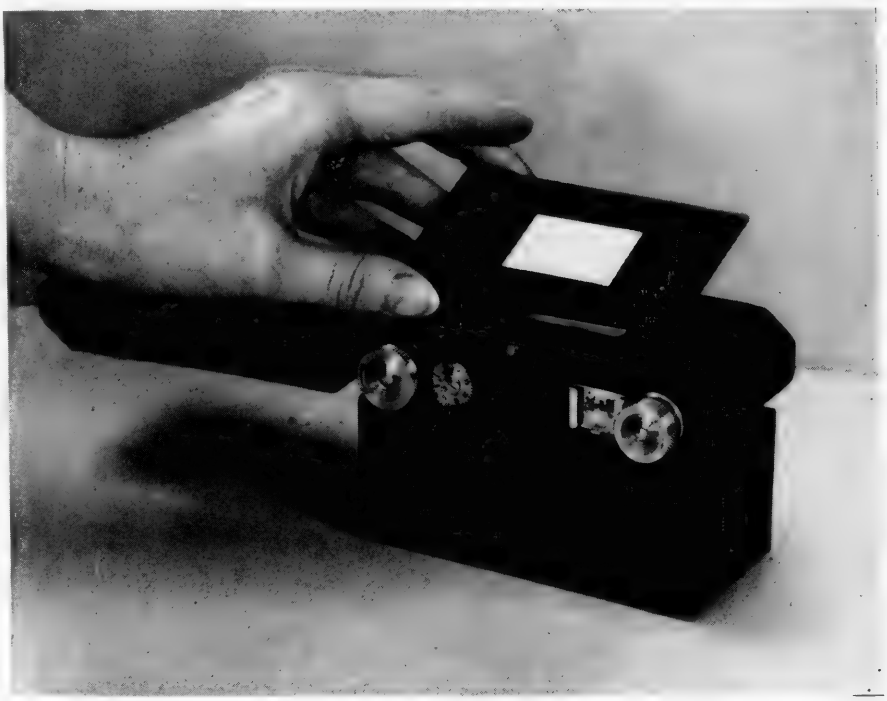


Figure 3

The positive film may be used in a 35mm camera following the general principles given here for the Retina I. The special items needed are illustrated in figure 1. "A" is a box to support the camera on the enlarging easel. This box or block should be extremely rigid to

prevent vibrations or shifting of the camera, accommodate camera projections, and keep the positive film parallel with the negative. "B" is a black substitute light-tight back for the camera. It has an opening slightly larger than the binding mat for the finished slide. "C" is a black light-tight alinement plate. This plate has a white area the size of the opening in "B" and registers with it. The positive film is loaded into a film cartridge with the *emulsion side out.* The film is otherwise threaded in the usual manner.

The camera is placed on the supporting box and the substitute back put in place as shown in figure 2. The negative image is focused and alined on the positive film through the aperture in the substitute back. The enlarger lens should be one of the projection type which has little or no objectionable stop difference of focus. Focusing should be done with a two to five power magnifying glass. Focusing of the first frame should be accomplished as soon as possible before the heat of the enlarger lamp buckles the film. Other frames in the same roll do not need to be refocused and the short exposure time eliminates any film buckling problem. Exposure should be made at a small lens opening. The focus should be checked as the rolls of negative films are changed.

When advancing to each succeeding frame, alinement is accomplished by placing plate "C" over the substitute camera back as shown in figure 3. This alinement plate should be keyed with the substitute back to insure proper register of the white area on the plate with the aperture in the substitute back. *This plate is for alinement only and not for focusing.*

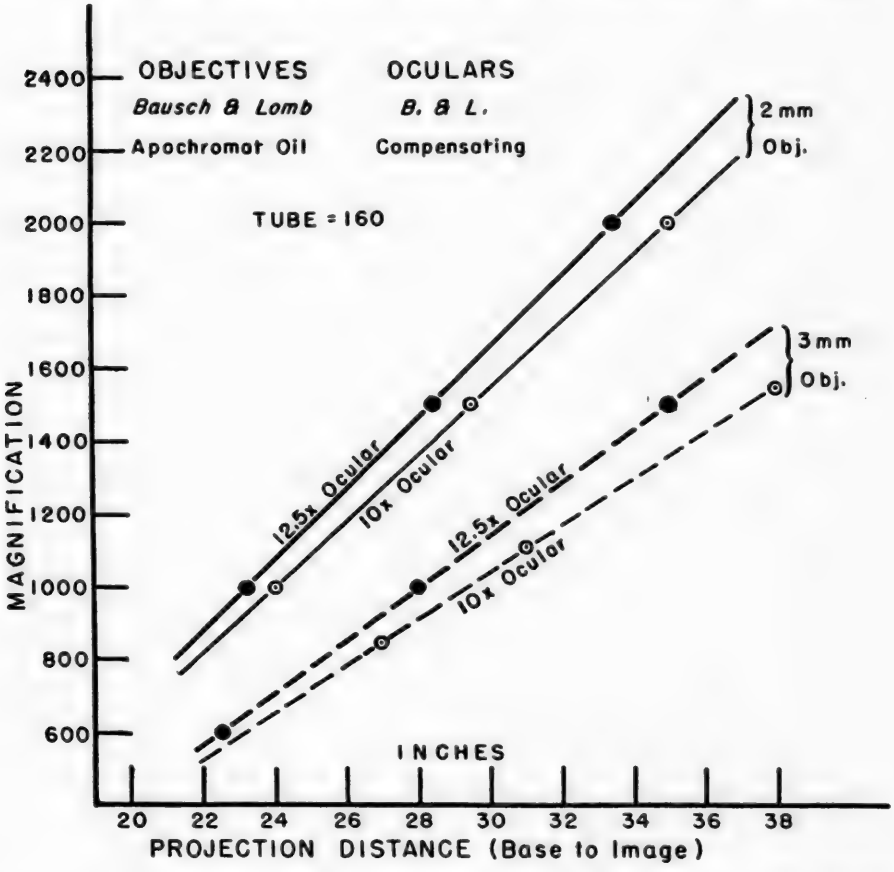
The exposure of the positive film should be determined by a wide range of test exposures as outlined in the discussion of copy negatives. The exposure for the first frame on any given negative roll should apply to all frames in that negative roll if the copy negatives have been properly balanced. The positive stock should be developed in one of the regular motion picture positive film developers, or in one of the common print developers. As opposed to paper prints, the highlights of a positive film image during development should appear heavily veiled similar in appearance to an overexposed paper print. The time of development should be such that when the finished print is projected it is highly comparable to the original subject matter. Experience with projected prints will be the best guide in determining proper density and contrast of the 35 mm positive prints.

This article has attempted to present a few fundamental ideas in the production of 35 mm transparencies and is not intended to cover a complete photographic technic. It is hoped that some of these suggestions may prove of practical value to the reader.

Recording Magnification in Photomicrographs

Alice M. Hellmer*

EVERY set-up used in taking successful photomicrographs should be carefully recorded for future reference. Such data should always include the magnification. This information, however, is often neglected, owing to the speed with which some biological specimens have to be photographed.



* Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, N.Y.
Received for publication June 26, 1944.

To obtain missing records on the magnification of several hundred micrographs, i.e., to work through the gamut of lens-combinations, bellows extension, etc., is a laborious undertaking. Yet, such a task confronts every photographer.

The accompanying graph shows how simply the problem can be solved by preparing magnification diagrams for all possible combinations of objective-eyepiece and projection distance. Measurements, of course, are made by using the stage micrometer.

Arrange two rectilineal scales on cross-section paper, the abscissa representing the projection-distance (equivalent with bellows extension), the ordinate measuring the magnification. The projection distance equals the distance between base plate and ground glass image. Ascertain the magnification for each lens combination at two points, that is with the bellows extended and bellows collapsed. Connect these two points by a straight line, then check the correctness of slope by locating two or three additional points at different bellows extension.

International College of Surgeons Meet

The Ninth Annual Assembly of the International College of Surgeons will be held on October 3, 4, 5, 1944 at the Benjamin Franklin Hotel, Philadelphia, Pa. The program will be devoted to War, Rehabilitation and Civilian Surgery. Eminent surgeons in government, military and civilian practice have been invited to attend and present papers pertinent to surgery in their particular field of endeavor.

Press release from Dr. Moses Behrend,
Chairman, Publicity Committee
Ninth Annual Assembly, International
College of Surgeons
1738 Pine Street, Philadelphia, Pa.

Photographic Society of America Announcement

The Photographic Society of America, seeking breadth of scope, will present a complete panorama of contemporary photography with a pictorial salon, a nature salon, and a color slide salon. Entries close October 5th and the pictures and color slides will be judged on October 7th and 8th. The show will hang in the Brooklyn Institute of Arts and Sciences from October 27th through November 19th and at the Chicago Historical Society for the entire month of December.

Photographic Society of America
The Franklin Institute
Philadelphia 3, Pa.

Notes on Clinical Photography

F. R. Harding and E. N. Armstrong*

CLINICAL photographs are usually requested prior to treatment or operation, but the staff physician often forgets to order post treatment pictures. This lack of thought about follow-up photographs often works a great hardship on research, sometimes years later, because there is no photographic evidence of the appearance of the patient after treatment. A pre-treatment photographic record is nearly always made, but it appears up to the photographer to educate staff members to order follow-up photographs so that the photographic record will be complete. The time to order follow-ups will vary with the type of case, usually the last follow-up visit to the hospital is sufficient, except in some orthopedic and surgical cases requiring multiple operations. There should be follow-up photographs before each new operation. The routine follow-up photograph is of real value to staff and student alike, and at least a determined attempt should be made to follow such a routine in all hospitals employing clinical photography.

The backgrounds used should be consistent for each patient. Photographs showing a patient against a white background today and against a black one next week make comparing of the photographs difficult. If they are published, unmatched backgrounds produce a spotty page of illustrations which is not pleasing. The writers prefer a black background for practically all clinical photographs. It is only for reasons of contrast or prevention of contamination that white backgrounds are employed. If a series of pictures is started with a white background for the reasons given above, all future pictures of the patient should be made the same, even though conditions change and there appears to be no reason for continuation of the white background.

Reflectors are not employed by clinical photographers nearly as often as they are by photographers in other fields. The proper use of reflectors will often be the difference between a useful and a poor clinical photograph. The reflector does not have to be elaborate. Several sizes may be made by the photographer for various purposes. Crinkled foil such as was wrapped around pre-war cut film, glued on wall board and fastened to any form of stand or tripod makes an excellent reflector. A softer reflected light will result if white cloth or paper is used. The

* From Children's Hospital, Boston, Mass. Received for publication July 21, 1944.

reflector may be employed to break up dark shadows that would otherwise require an extra light. The writers use one large reflector 2½ x 4 feet primarily on standing figures, another about 8 x 10 inches is used to break up shadows on gross specimens. Several others are used for special purposes. A little experimenting must be made in placing the reflector so that too little or too much light will not be put into the shadow. Sometimes, if the shadow area is small, a small mirror will act perfectly as a reflector. This is useful in getting light into cavities in gross specimens.

Many contact printing machines have a glass printing surface much larger than the negative size. In such cases, time can be saved if two negatives are printed at the same time. Either one sheet of printing paper large enough to cover both negatives, or two sheets of the same size as each negative, may be used. It is necessary that both negatives have the same density to the eye, and that both take the same contrast grade of printing paper. If this is done, up to 50% of processing room time may be saved.

A spare minute used in making up solutions and storing in bottles ready for use will pay big dividends sometime when new solutions are needed in a hurry. A spare fixing bath will keep for weeks in a bottle with a tight stopper. The developer should be stored in brown bottles with extra care given to see that they are filled to the top and then tightly corked so that there will be no room for air in the bottle to cause oxidization. If the individual is not a large user of developer, it can be made in gallon lots and then bottled in pint or quart bottles. After a bottle of developer is emptied, it should be rinsed with cold water immediately. Developer once used should never be poured back into the bottle and saved. Old developer which has discolored with age should never be used because prints developed in it will be of very poor quality. Old developer causes a muddy tone, slow development, and a lack of contrast in the print.

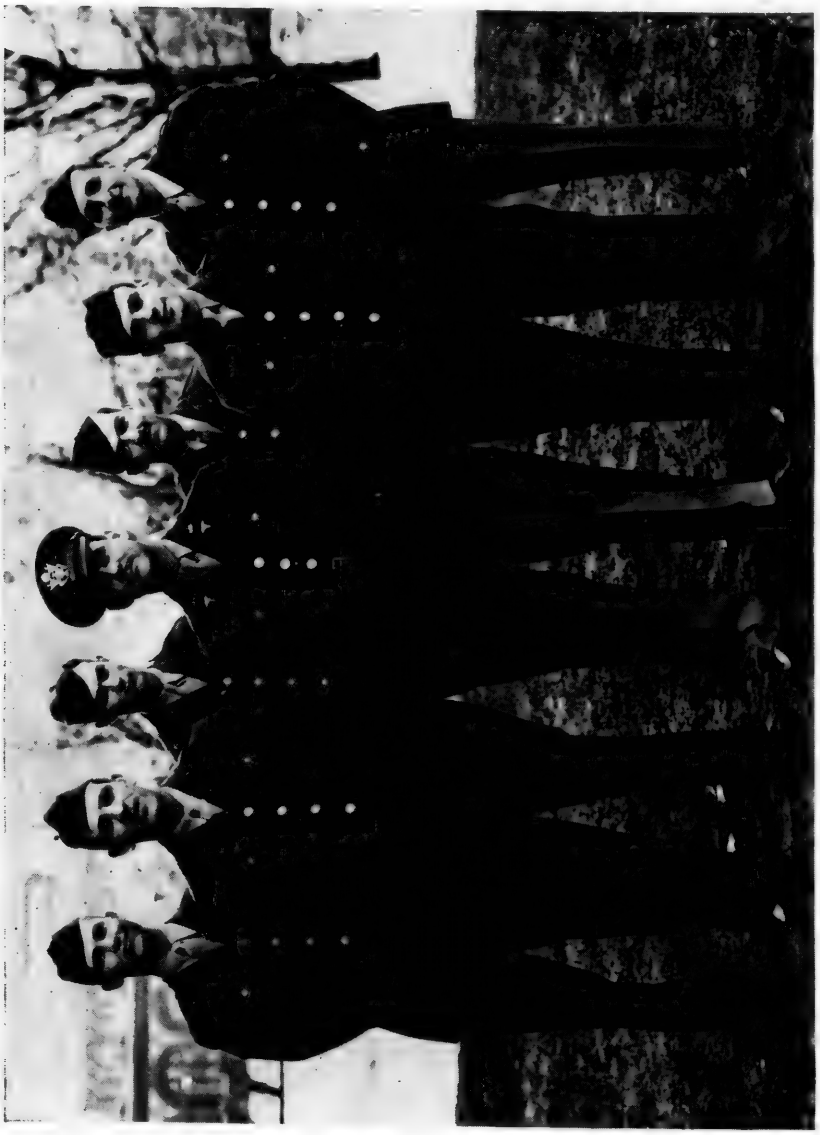
The employment of color film requires a much more critical determination of exposure than is true of black and white film. An exposure meter, and some method of computing the effective lens aperture should be used as much clinical photography is done "close-up." The effective Lens Aperture Kodaguide offers a simple but accurate means of getting the correct aperture. Some consistent underexposures in color photography can be traced to not computing the effective aperture. If the lens to object distance is less than eight times the focal length of the lens used, the f marks on the lens will not be correct, and the effective f mark must be computed before the correct exposure can be read from the meter.

The value of having prints mounted neatly and with sufficient data printed on the photo sheet to identify them even when they are not incorporated in the clinical record cannot be overemphasized. Dry mounting has proven to be far superior to any other method because of its neatness, the speed with which it can be used, the flexibility of the print after mounting, and because of its durability. The photo sheet should have the name of the patient, the record number, the date, the diagnosis, the ward, and the name of the doctor who requested the photograph typed neatly at the top of the page. This saves a great deal of time for anyone reviewing the case quickly. The pictures should be mounted as squarely and neatly as possible. Sometimes the doctors prefer to have only one or two pictures on a sheet so that they may write explanations below the photographs. Every effort should be made to get the photos mounted and incorporated in the clinical record of the patient, the protocol, or report as quickly as possible. A gray, double weight mounting stock, punched for easy insertion in the record, has proven to be very satisfactory. Prints with either black or white backgrounds look well on paper stock of this color and it does not show soil from handling readily.

Many institutional photographic departments are not used to the fullest possible extent by the institution. There are many ways in which photography can aid beside the obvious scientific aspects. Publicity, photographic records of the property, new construction, illustration of Annual Reports, photographic signs (much neater and cheaper than hand-lettered signs. Set up the text on a black board with movable white celluloid letters, make a process negative and then enlarge, mount and frame, and a sign is born). Look around you and suggest ways in which your photographic skill may be employed.

Some confusion can be avoided in the processing room if the fewest possible types of film are used. For example, the writers do all their work using one good panchromatic film for all clinical and pathologic photography and for copying photographs and other full tone subjects; one type of process film for line copies; a long scale ortho film for copying x-rays; and some infrared film. All films are loaded and processed in complete darkness and are developed in the same developer. If one has a thorough understanding of what each film will do, it is remarkable how few kinds of film will suffice.

Many institutional photographic departments routinely file one print of each negative in the negative envelope. Most departments have few calls for reprints, time and material can be saved if a print is made for either the record or the individual ordering the work done, whichever is the custom of the institution, and no print filed with the negative. It takes only a few minutes to make reprints if they are called for at a later date.



FIFTH DETACHMENT, MUSEUM AND MEDICAL ARTS SERVICE *(Central Pacific)*

Rear row:
Sgt. Edgar E. Bumbier, Pfc. Raymond Olivere, Cpl. Wendell F. Barrows, T/Sgt. Harold C. Baitz
Front row: Sgt. Milton F. Kougl Lt. Ted Bloodhart Sgt. Eugene Z. Parro

*Medical Audiovisual Education in the U. S. Navy**

Captain Joseph S. Barr, MC-V(S), U.S.N.R.

In Charge, Section of Audio-Visual Education,
Division of Preventive Medicine, Bureau of Medicine and Surgery
WASHINGTON, D. C.

THERE is a tendency — well nigh universal but particularly well developed among doctors — to obscure one's meaning by choosing polysyllabic Greek or Latin words in place of the simple, homely Anglo-Saxon synonyms. I would therefore like to have you think with me for a few minutes, not about "audiovisual education" but about "medical teaching aids," their development and their use in military and civilian life.

War has brought home to us many truths, and one in particular has been impressed on us—the art is long, the occasion instant. We have found that modern war can be waged only by skilled, trained men. Too well we know that it takes time to produce such men—to shape their minds, to guide their hands in the technics of the arts and sciences so that each individual acts for the best interests of his country and of humankind. Such guidance is in the broad sense education, which is said to reach its highest form when the skilled instructor is on one end of a log, an attentive student on the other.

Unfortunately, this favorable situation is not universally existent today. In time of war there develops a scarcity both of logs and of teachers, and there press on us also the strategic limitations of time. Particularly are these factors potent in the military medical scene.

There is no scarcity, however, so far as pupils or needs are concerned. Consider, for a moment, the health and medical indoctrination and training burden the Navy must successfully carry today:

First, every man and woman in the Navy and in the Marines, afloat and ashore, must follow a productive understandable regimen of personal hygiene.

Second, every man jack must possess a working knowledge and practical ability in the fundamentals, at least, of first aid. Manifestly, the teacher-log-student relationship must be somewhat altered when

* Reprinted from the Journal of the American Medical Association, June 3, 1944.

the class comprises more than two million persons. Yet such mass educational technics as may be applied must to a considerable measure be personalized in their effect.

Third, keeping in step with the growth of our seven ocean Navy, there has been a tremendous expansion of its Medical Department. Today, in fact, the Medical Department is larger than the prewar Navy in its entirety. Obviously, this has meant a tremendous increment in ancillary medical personnel, especially the hospital corps. Here the task has been that of taking completely untrained youths and turning them into men and women capable not only of assisting medical officers under organized ship and hospital conditions, but also of functioning not infrequently completely "on their own" aboard small craft, with invasion forces and so on.

The average time now allotted to that training is nine weeks. This includes six weeks in hospital corps school and three weeks in hospital wards. To take a boy from high school, farm or factory and give him training equal to that of a graduate nurse in nine weeks is impossible, but it has to be done or at least approximated.

Finally, as the bulk of our medical officers, including myself, have come from civilian professional ranks we have been faced with the necessity of learning the specialized art of military medicine.

But the technology of war finds a partner in the healing arts which takes scientific advances in stride. As our bombers carry ever heavier loads higher and farther, the flight surgeon raises the threshold of man's ability to carry through such missions. As our submarines prowl ever closer to the enemy ports, their "clean sweep" reflects the medical department's care in crew selection, hygiene, diet and working environment. Obviously, these and the multitude of other new and developing problems dictate a continuing, aggressive "postgraduate" training of each and every medical officer, be he surgeon or internist, authority or general practitioner.

Patently, every good device and technic must needs be utilized to aid in the training of a total Navy personnel fit to fight and fit to win. However, in the consideration of medical teaching aids the emphasis should be placed on the term aids, for the purpose is not to supplant but to supplement the work of the teacher.

While medical teaching aids embrace a wide and interlocking variety of devices, ranging from the simple blackboard sketch, the printed chart, the lantern slide to the sound-color-motion picture, I shall consider here only those of a more advanced audiovisual character. And perhaps rather than attempting a didactic exposition of what such an audiovisual device is, I can best describe by citing examples in terms of the aforementioned problems.

Personal hygiene is the first line of defense in the carrying out of the Navy Medical Department's mission "to keep as many men at as many guns as many days as possible." The health of the Navy as a fighting entity is partially an individual responsibility, dependent on every man's obeying the basic laws of personal hygiene. The several films on this subject which have been produced by the Navy serve as a focal point of a continuing effort to inculcate knowledge of the rules of personal hygiene and to indoctrinate every man and woman in the Navy to the point where he or she obeys automatically the basic precepts of bodily cleanliness, exercise, sleep, care of the teeth, nutrition and reporting for medical care at the first intimation of illness.

It is not alone facts, however, which produce such results. It has been found in practice that holding equal importance with the fact—the "what to do"—is the "why." And even in such mundane matters as personal hygiene it has been found to add to the effectiveness of the health training effort to appeal to the men as shipmates, to draw on the spirit of cohesiveness which counts for so much in the fighting team and to build a belief and a feeling of security in the ability of the Medical Department to hold up its end.

The educational approach to the problem of venereal disease is a prime example of the role of motion pictures in health indoctrination and a specially pertinent case in point when it becomes necessary to go beyond the facts to produce a desired result. The straightforward facts of syphilis, gonorrhea and chancroid as diseases need to be highlighted; and the deeply misunderstood facts of sex hygiene must be clarified. But although lack of knowledge may be the basic cause of many cases of venereal disease, it is not by any means the only cause.

Many a man who knows the basic technics necessary to avoid venereal disease nonetheless falls a victim to it. Avoidance and prevention of venereal disease—and all that it implies—involves a complexity of factors environmental and within the man. By and large, these factors are outside the control of the Navy, for they bear on the man from non-naval sources and during liberty hours. Prevention of venereal casualties, therefore, is largely in the hands of the individual sailor or marine, and it becomes one of the functions of audiovisual education to attempt to bring to his consciousness, both intellectually and emotionally, the peculiar role which he plays, how his role affects the Navy as a whole and how his role affects his personal life and his future. Adult restrained sexual behavior can be taught—and must be taught—if our civilization is to endure in full vigor.

Our experience suggests that motion pictures can further proper emotional conditioning—or they can help destroy it. I believe that psychologically we have in the motion picture a most powerful tool,

and that it can be and that it will be used to help better the behavior patterns of all of us. We are a part of all that we see; all that we see is some part of us. The average American spends a good many hours each month looking at motion pictures. It seems doubtful that all of these films are pure opium to his senses. Witness—as only one example—our habits of dress and style, largely "made in Hollywood."

Another formidable all-Navy training task is the teaching of first aid. Six motion pictures and a set of sound slide films have been made specifically for Navy personnel. Every one in the Navy must be able to give elementary first aid. Because professional medical care is not immediately available in all the watertight compartments of a fighting ship, the sailor himself must know the simple rules for the arrest of hemorrhage, dressing of wounds, splinting of fractures and safe transportation of the injured.

Those who go down to the sea must know how to give artificial respiration. To train over two million men in less than two years even in the most simple arts of first aid has proved a tremendous task which is never done. Many a holder of a Purple Heart is thankful his buddy saw and studied the technics of first aid with the benefit of the close-ups of a motion picture.

Beyond first aid and personal hygiene must always stand the professional medical organization. In the training of the basic echelons of the Medical Department lies a major field of action for audiovisual education.

Medical professional training of enlisted personnel—the hospital corps—is accomplished by a combination of intensive didactic courses in hospital corps schools and by practical hospital apprenticeships. Time severely limits both types of activity. The "learn by doing" technic is compressed to its limits. It is here that motion pictures enter and make possible basic instruction in technics and give as well a certain over-all concept immeasurably valuable and necessary to the intelligent student.

The Bureau of Medicine and Surgery is at present making a series of films under the general title "Care of Sick and Injured by Hospital Corpsmen." Each film in the series is a short (ten to twenty minute) but clear exposition of some basic nursing procedure, including how to take a blood pressure, bathing the bed patient, how to take and record temperature, pulse and respiration, how to do surgical dressings in the ward, how to recognize and care for neuropsychiatric patients, and isolation nursing technics for contagious patients. The list is being extended because the films are proving, in practice, to be extremely valuable. I would expect that civilian nursing instructors will find them most useful when they can be made available, post bellum.

Motion pictures are playing a modest but definite role in the training of our medical officers. As a first step we have reviewed all available medical motion pictures and will continue to review current productions with a view to making available all films which will add to the professional information of the medical corps. Beyond this we have undertaken to produce motion pictures on topics of special importance to the Navy at war. Films on emergency amputation, on the use of skeletal fixation in fractures, on war injuries of the head, on the use of serum albumin and dried plasma, have been or are being made. A film on "Clinical Malaria" is complete and should prove of real value in giving medical officers a basic indoctrination and attitude toward this the most important of all the infectious diseases.

In time of war the trend of medical activity is of necessity largely shaped by the character of military operations. In times past, however, reports of conditions at the front not only were substantially delayed but had to come in words, occasionally illuminated by still photographs. Today it is possible to report from the battle areas in terms of color motion photographs the actual conditions under which medicine and surgery must be practiced. The implications are far reaching, and in order to realize some of them, at least, the Medical Department of the Navy has activated four production units for medical motion picture photography. Each unit is equipped to take color motion picture films and stills of professional quality. Two units are located at large naval hospitals within the continental limits of the United States and two are overseas, one in the Atlantic theater of operations and one in the Pacific.

Documentary films and still pictures of the treatment of casualties from the moment of injury to eventual return to duty—followed step by step from the first aid battle station to the sick bay, to the hospital ship or base hospital to the States—are now being made. All the multitudinous activities of the Medical Department of the Navy are subject to recording on film, not only for historical purposes, but also for the immediate information of medical units in action and to serve as the nucleus for many instruction films.

I trust it would not be out of order at this point to insert a few miscellaneous remarks about instructional sound-on-film motion pictures, with particular reference to their use by orthopedic surgeons.

When one listens to the radio or to a lecturer who is not illustrating his talk, only the sense of hearing is involved. One's eyes may in fact prove a distracting influence, and many persons find that attention to the matter in hand demands that their eyes be closed and visual impressions reduced to a minimum. Unfortunately, the run-of-the-mine lecturer's style and delivery is likely to make the closed-eyed technic somewhat dangerous.

The man who is learning by reading or by looking at a silent motion picture or other graphic presentation, on the contrary, finds his attention distracted by extraneous sounds. Further, even when illustrations are used with the textual matter, their time-space relationship is such that close integration is virtually impossible.

But those who make entertainment films, and more recently those who make instructional films, have found that audience interest is highest and complete attention is most easily obtained if sight and sound are synchronized to complement each other. Learning by hearing and learning by seeing are interlocked in time and space. The listener hears and sees the subject as it is unfolded; there is no competition between stimuli for the center of consciousness. The only escape from participation in such teaching is to walk out.

Effective instructional films of high quality are neither cheap nor easy to produce. All of us know how many hours of work go into a good illustrated lecture (but let me hasten to say that similarity between a good instructional film and an illustrated lecture is largely coincidental). Multiply such efforts tenfold, even a hundredfold, and one can gain some conception of the amount of preliminary preparation required before a single camera can grind. Specific attention must be given to a wide variety of elements: What is the film's mission? To whom is it directed? By whom will it be used? How does it fit into the training or informational plan? What is the specific content? What production technics are indicated (such as live sound photography, animation, color)?

These basic decisions reached, and an action outline of the proposed film carefully prepared, the next step becomes the preparation of a detailed shooting script. This is a task requiring training and experience and a certain talent that can translate into clear, concise language both the graphic (or visual) and the verbal (sound) content of the proposed film in such a manner as to result in the ultimate creation of the desired result after the photographers, actors, soundmen and other technicians have brought their efforts to bear. In short, it is distinctly an exception to find a good teaching film that has not first been born on paper, after a prolonged period of labor on the part of technical experts and an experienced medical script writer.

As one who has been through this rather debilitating process a fair number of times recently, I would say this—with the hope of saving some one from a heart-rending experience: Beware of taking a camera and trying to film an instructional picture without first writing a script and reviewing the practical elements of the problem. Delay, frustration, failure and an unwarranted prejudice against films as teaching aids are more than likely to result from shooting "off the cuff." With all due

respect to my colleagues' abilities, it is a fact that, while many physicians are good amateur photographers, only rarely do they even approach true professional photographic ability. Just as it takes years to acquire surgical skill, so it takes comparable time to become a first rate professional motion picture photographer, producer, director or script writer. These are special fields of special skills. The surgeon who is making teaching films should demand that his technicians possess such skills.

Let us suppose that a script has been prepared and that all the scenes called for have been photographed. The last stage in film production has not yet been reached. The cutting room floor has not only been the last resting place of many a promising actor's face, but also has been (or should have been) the interring ground of many an ill thought out medical instructional film. After cutting and editing come the final rewriting of the narrative, the recording of the sound track and, finally, production of the combined sound on film print. All of these processes demand particular abilities and special equipment. And the net result is that production of good teaching films is time, energy and money consuming.

Production costs run from two to twenty thousand dollars per reel, perhaps an average of eight or ten thousand dollars for each ten minutes of screen time. Yet a film on venereal disease which costs, let us say, $30,000 is seen by two million or more men at a per capita cost of 1.5 cents. If a film on the management of war injuries of the head—costing perhaps $15,000—leads to the saving of even one American sailor's life, it is worth every cent it cost, and more.

Those of us who teach orthopedic surgery are becoming more and more aware of the value of instructional motion picture films. If, for example, we are teaching students the analysis of gaits, with motion pictures we can show examples of all the characteristic gaits, the muscular weakness, the nerve or joint involvement and so no. Using clinical cases such a demonstration would be most difficult if not impossible to arrange and could not be easily repeated. One properly made film on this subject could be utilized by all medical schools and in many hospitals where postgraduate intern instruction is being carried on.

In conclusion, I would like to bring to attention as succinctly as possible the following points:

Although physicians have made and may well continue to make many amateur or semiprofessional motion picture films, there is an unfilled and pressing need for basic teaching (sound motion picture) films of the highest professional quality.

The value of such films in undergraduate and postgraduate teaching cannot be overestimated. Osler himself could not in an hour's

clinical lecture indoctrinate a class of medical students in the protean aspects of typhoid or syphilis as well as a good teaching film could do it.

Osler, alas, is no longer available except in a textbook form. Good films on these and all the other medical subjects which students must learn can be and will be made available in the future.

How is that to be done? Government sponsored agencies may be forced to assume the burden, but a larger part of the task rightfully belongs to nongovernment institutions, particularly medical schools and teaching hospitals. Consider this possibility for a moment: If each medical school produced only one good teaching film every year—pooling resources and avoiding duplication of effort—we would very soon have a valuable teaching library of medical films. The prerequisites for such a happy situation are an interest and will for the task plus cooperative, intelligent planning, plus the basic financial means. The Academy of Orthopaedic Surgeons numbers in its membership teachers in all the accredited medical schools. They can exert, if they choose, sufficient effort to influence favorably the course of professional education. Cooperation, vision and leadership are required to initiate such a program. I leave the challenge with you.

Des Moines Salon

The Tenth Annual International Salon of the Des Moines Y.M.C.A. Movie and Camera Club will be held from January 1 to 22, 1945 in the Hall of Photography, West Fourth Street at Keosauqua Way, Des Moines, Iowa This salon will be conducted according to the rules and practices approved by the Photographic Society of America. The last day for receiving prints is December 10, 1944.

Walter Vittum, Salon Director
Y.M.C.A. Building, Des Moines, Iowa

ERRATUM

Volume XII Number 4, page 162 line 21:

" . . . highest ocular used . . . " should read
" . . . highest objective used . . . ".

Association News

FOURTEENTH ANNUAL MEETING

An important program is being planned for our Convention in Binghamton, N.Y., September 7, 8 and 9. The emphasis will be on color, new equipment, and progress in visual aids.

In the field of color, Ansco will demonstrate its new film and paper, including a color printing method. Development of these materials will be carried out in detail, to show how simply they may be processed in the photographer's own dark room. "Color from the Photo-Engraver's Point of View" will be presented by Mr. A. Dempsey of the Donovan and Sullivan Engraving Company, Boston.

New equipment and methods will include the "Surgiscope", a camera designed by the Adel Precision Products Corporation, Burbank, Cal., to permit sterile technic in the operating room. "Optical Staining", an interesting method of microscopical illumination to be presented by Mr. G. L. Royer of the Calco Chemical Division, American Cyanamide Company, while not precisely new, is an unknown field to most of our members. The Ilex Acme Synchro Shutter synchronized for both the SM lamp and other types of flashbulbs, will be on display. A recent hypersensitizing technic will be demonstrated by Ansco.

Dr. Bruce Buckler, Director of Visual Education for International Business Machines will present "New Technics in the Preparation of Visual Aids". Captain Ralph Creer, AUS, will tell us about the illustrative material being collected in various theatres of war by the Army Medical Museum. Mr. Emil Davidson will display the year's additions to the Clay-Adams Medichrome Library of 2 x 2 inch color slides for medical teaching.

There will be papers of general interest such as Mr. Ferdinand Harding's "The Photography of White Objects;" and papers on special biological problems such as "The Photography of Live Fish in Tanks" by Mr. H. L. Gibson of the Eastman Kodak Co. Dr. Oscar Richards of the Spencer Lens Company and Mr. Leonard Perskie of the Defender Photo Supply Company will read papers. Mr. Lardner Coffey of the Mayo Clinic will talk on "Experiences with Photography in Aviation-Medicine" and will show a short film made by him on this subject. There will be other interesting papers, but these cannot be definitely announced at this writing.

In spite of the difficulty of arranging technical displays these days, several old friends and one or two news ones will represent their firms in the commercial exhibit. The Eastman Company, Ansco, Defender Photo Supply, Clay-Adams, Adel Precision Products Corpo-

ration, Ilex Optical Company, are among those who have reserved tables, and one or two others are trying to complete their arrangements.

The Salon will as usual be one of the important features of the meeting. This is the only Salon that offers the biological photographer an opportunity to show his work exclusively with that of his colleagues, and every member should avail himself of it.

One of the highlights of the meeting will be a tour of the Ansco plant. *No visitor will be permitted in the plant without a birth certificate. Passports will not be acceptable.*

On Friday night, September 8, Ansco will entertain the Association at a cocktail and informal supper party at Ansco Lake. The Arlington Hotel will be headquarters throughout the Convention. No scientific photographer should miss this meeting who can possibly arrange to be present.

SUSTAINING MEMBERS

Some individuals who have a deep interest in the advance of scientific photography help finance a wider range of activities for the Association by becoming Sustaining Members. The privileges of Regular and Sustaining members are the same. Either type may be chosen each July when the dues are payable.

Cammon, W. A. "Don", D.O.S.
Cameron Surgical Specialty Company
666 West Division Street
Chicago 10, Illinois

Davidson, Emil
Clay-Adams & Company
44 East 23rd Street
New York 10, N.Y.

Flory, Louis P.
Boyce Thompson Institute
for Plant Research
1086 Broadway
Yonkers 3, N.Y.

Gibson, H. Lou
Eastman Kodak Company
343 State Street
Rochester 4, N.Y.

Horton, Nathan S.
Ayerst, McKenna & Harrison, Ltd.
Rouses Point, N.Y.

Lester, Henry M.
101 Park Avenue
New York 17, N.Y.

Mallory, 1st Lt. Robert III
131 General Hospital
A.P.O. 5541, c/o Postmaster
New York, N.Y.

Perskie, Leonard L.
Defender Photo Supply Co., Inc.
275 Seventh Avenue
New York 1, N.Y.

Proetz, Dr. Arthur W.
1010 Beaumont Building
St. Louis 8, Mo.

Semken, Dr. George H.
16 West 85th Street
New York 24, N.Y.

Shiras, Miss Anne
University Office, Magee Hospital
Pittsburgh 13, Pa.

Varden, Lloyd E.
Ansco
Binghamton, N.Y.

PLEASE NOTE

Have you taken any pictures of Eye, Ear, Nose and Throat?

The Chicago Chapter will hold an exhibit as usual when the ophthalmologists and otolaryngologists meet in Chicago early this October. Material from the members is needed for this exhibit and if you have pictures in these fields, we urge you to get in touch with Miss Avis Gregersen, Secretary of the Chicago Chapter, 1422 Sedgwick Street, Chicago 10, Illinois.

The B.P.A. exhibit has become a regular feature of this scientific meeting. Many of the doctors who attend the meeting are interested in luminography and infraradiography. Developing new technic in photography in these fields as possible.

NEW WORK REPORTED

One of the purposes of the B.P.A. is to help members find other workers in their own particular fields. You may therefore be interested in looking over the new work of members listed among the early renewal blanks. Motion pictures are not listed unless they involve new equipment or new fields of activity, as all motion pictures reported by members will be listed on the reports of the Motion Picture Committee. New activities noted on renewal blanks received after this number went to press will be listed later.

William R. Berkhofer, 51 Hillside Place, Ridgewood, N.J. Experimenting on exposure control, with exposure meters at focal plane. Has been in touch with Mr. J. Maurer who wrote an article on this subject in the J. Biol. Photo. Assn. 12:4—June, 1944.

J. D. Brubaker, 805 Greenleaf St., Evanston, Ill. After doing research-work and designs for corporations, has returned to his own business of designing and building special scientific apparatus and medical endoscopic cameras.

Professor C. T. Brues, Biological Laboratories, Harvard University, Cambridge, Mass. Has been doing fluorescent microphotography in the yast year.

W. A. "Don" Cammon, Cameron Surgical Specialty Co., 666 W. Division Street, Chicago 10, Ill. Gastrophotography and cysto-photography on Kodachrome with new Cavicamera through lens-filled endoscopes.

Emil Davidson, Clay-Adams Co., Inc., 44 E. 23rd Street, New York 10, N.Y. Kodachrome teaching slides on biomedical subjects, photomicrographs, etc.

H. Lou Gibson, Eastman Kodak Co., Rochester 4, N.Y. "Principles of Photographic Copying", Radiography and Clinical Photography, Vol.

19, No. 2 pp. 44-51; Vol. 19, No. 3 pp. 70-75. "The Why and How of Copying" Popular Photography, Part I, Vol. XIV, No. 5; Part II, Vol. XIV, No. 6.

Frank E. Hart, 2841 S. Superior St., Milwaukee 7, Wis., Allis-Chalmers Mfg. Co. High speed 16 mm motion picture photography (4000 frames per sec.) on new Hi Speed Faxtex Camera.

Frederick J. Kraus, 31 Lincoln Park, Newark 2, N.J. Recording of various types of skin lesions, occupational dermatoses, plastic surgery cases on 3¼ x 4½ Type B Kodachrome, using photoflash technic.

I. Lloyd Matlovsky, 3639 Nichols Ave., S.E., Washington 20, D.C. Optical and photomicrographic work at U.S.N. Photo Science Lab., Anacostia, D.C.

Adolph Nichtenhauser, Section on Health and Medical Films, American Film Center, 45 Rockefeller Plaza, New York 20, N.Y. Collaborated with New York City Nutrition Program on a catalogue of "Approved Films on Food and Nutrition". Revision of 20-reel series "Neurological Cinematographic Atlas" by Dr. S. P. Goodhart, under a grant from the National Science Fund of the National Academy of Sciences.

Oscar W. Richards, Ph.D., Spencer Lens Co., 19 Doat Street, Buffalo 11, N.Y. Chairman, subcommittee F of the American Standards Association War Committee of Photography. F includes printers, enlargers, slidefilm and lantern slide projectors.

Dr. Irving Rehman, Dept. of Anatomy, School of Medicine, University of Southern California, Los Angeles 7, Cal. Atlas of Human Dissection—in Transparencies.

Ernest Rosenthal, 18 Asylum Street, Hartford, Conn. New Ansco Color Film tested in photography of the fundus and in the stereophotography of the anterior segment of the eye.

Albert Sadler, Eloise Hospital, Eloise, Mich. "Some Aspects of Photomicrography", J. Biol. Photo. Assn. 12:4—June, 1944. "Medical Photography" American Annual of Photography, 1945 Edition.

Anne Shiras, Magee Hospital, University of Pittsburgh, Pa. Experiments in photomicrography on Ansco Color Film with 108 watt, 6 volt, ribbon filament lamp.

Lloyd S. Varden, Ansco, Binghamton, N.Y. "Color Temperature", American Photography, June, 1944. "Fluorography" Section in Medical Physics, 1944. "Aspects of Color", American Annual of Photography, 1945.

Glen E. Wade, Salem Deaconess Hospital, Salem, Oregon. Work in luminography and infraradiography. Developing new technic in photomicrography.

FORESTRY

The Journal of the Biological Photographic Association

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EDITOR

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Kodachrome Photography of Tropical Fish in Their Own Tank

H. Lou Gibson*

IN a previous article† a method for obtaining clear color photographs of tiny tropical fish in small glass cells was described. That method has minor disadvantages even with tiny fish, in that it involves carefully drugging them to slow down their motions and to calm them so that colors lost from the excitement of transfer are restored.

In applying the procedure for photographing larger fish, it was found in addition that the dimensions of a suitable cell have to be increased disproportionately to prevent reflections and rear corners of the cell from appearing in the photograph. Hence, a standard fish tank might as well be used, provided it has a clear, plate glass, front.

Such a tank has many advantages that make it more practical for holding such fish for photography. When the one in which the fish are regularly kept is utilized, there is no need to transfer and drug them. Again, the plants in a regular tank don't have to be disturbed from chasing the fish with a net. And finally, there is no danger of harming rare or costly specimens from possible accidents in handling.

This article deals with a convenient method of gaining these advantages. The procedure can be adopted easily by the biological photographer, or the amateur tropical fish fancier. It can be applied to photographing fish of practically any size from about one inch long or larger and for other underwater creatures, in black-and-white or color. A word on photographing the entire tank is appended.

Considerations in Fish Photography

Any setup for photographing fish must fulfill the following requirements:

Avoiding Reflections. First, reflections of the light source in the front glass of the tank must be avoided. This can be done by applying the

* From Eastman Kodak Company, Rochester, N. Y. Presented at the Fourteenth Annual Convention of the Biological Photographic Association, Binghamton, N. Y., September 9, 1944. Received for publication October 23, 1944.

† Journal of the Biological Photographic Association, Volume 8, No. 1, September '39, pages 1-5.

principles of copying glossy originals—making the camera axis perpendicular to the glass and using a 45-degree lighting.

Second, a troublesome reflected image of the fish itself occurs at any glass-air surface behind it, so that the fish should not be photographed against a rear wall of any tank (such as the narrow type sometimes built for photography). Instead, the fish should be confined against the front wall of a regular tank with a separate piece of glass in the water. An opaque retaining panel should not be employed, since a shadow of the fish would appear on it, thus destroying the underwater effect.

Third, reflections in the glass of the camera front and of other light-toned objects in front of the tank will surely appear in the picture unless they are shielded. The easiest way to do this is to prepare a black card about twice the size of the camera field and to shoot through a hole just large enough to clear the lens.

Allowing for Shallow Depth of Field. The photography of fish is essentially an exercise in close-up photography—with the attendant lack of leeway in depth of field. The problem lies not so much in the shape of the subject (most fish are to be photographed broadside on, anyway) but rather with insuring that the fish is at the correct distance from the camera lens when the picture is taken. This can be accomplished by focusing the camera at a distance, behind the inside front glass of the tank, slightly greater than the length of the pectoral fin of the fish to be photographed. The fish can be forced to swim approximately in this plane with the glass retaining panel by placing the latter at a distance behind the front glass of the tank slightly greater than the width of the fish with its pectoral fins extended. Then, if an aperture of about f.11 is utilized, sufficient depth of field is provided to accommodate the subject.

Providing Backgrounds. In a planted tank, most of the plants behind the fish would not be in focus. Hence, they would provide a rather spotty background. Again, since the light source has to be used close to the subjects, the illumination does not "carry" very far behind them; accordingly, plants at the back of the tank or backgrounds such as cards outside the tank are prone to be too dark from weak lighting.

These factors make it desirable to place an opaque background inside the tank about six inches from the retaining panel. Such a background should be sufficiently large to take care of the expanding field of view of the camera. A few plants can be located close to the rear of the retaining panel. Apart from these, the space should be kept clear. In this way the plants photograph slightly out of focus and a feeling of depth is thus lent to the picture. On the other hand, the

plants are not so far out of focus as to appear as shapeless, distracting, blobs.

Backgrounds should be available in two or three tones so that suitable tone contrast can be introduced between them and fish of various tones. They should not be too dark or details in the fins of the subjects will be lost. Neither should they be too light or the fish will appear to be pinned to a card. For color photography some shade of brownish green is usually suitable.

Lighting to Accommodate Subject Motion. This is an important consideration in making close-ups of such active subjects as fish. It is often desired to work at 1:1 or even at a small magnification; hence, the slightest motion during the action of the shutter results in a noticeable blur. Therefore sufficient light must be provided to permit an exposure time of 1/200 of a second or shorter. Since, in addition to such a short time, the factor must be included for extended bellows draws, and since reflectors must be omitted because of a cramped working space, considerable illumination is needed. It is inviting a tankful of parboiled fish to utilize Photflood lamps; Photoflash lamps provide the solution.

It might seem that an SM bulb, used with an open flash technic, would be suitable. However, while the motion-stopping capability of such a procedure was found fairly satisfactory, a single lamp produced about one-third of the light need for Kodachrome Film, even when located as close to the front glass of the tank as 45-degree lighting would permit. In placing three lamps in standard electrical sockets far enough away from the field to preclude their showing in the picture or their causing flare or reflections, so much distance had to be lost that the benefit of the extra light was nullified. It would be possible

to improvise special sockets for compact grouping, but three lamps are cumbersome and expensive to use in any event.

These factors led to the adoption of a single, bare, No. 22 Photoflash lamp for each shot, synchronized with the shutter at 1/200 of a second. A mirror was used opposite the lamp to pick up the flash and reflect the light for filling in the shadows. With the tip of the bulb at six inches from a fish in the center of the field, an aperture of f.11-16 with Kodachrome Film Type B was possible for fish of average tones. The usual half-stop allowance was made for light- and dark-toned fish. The magnifiation was ¾-scale. This data can be used as a basis for slightly different lamp distances or for other magnifications by making the usual compensations.

Description of Setup

The diagram shows a convenient setup for putting the foregoing suggestions into practice. It is of course, imperative to clean the inside of the front glass of the tank with cotton to remove algae before preparations are begun.

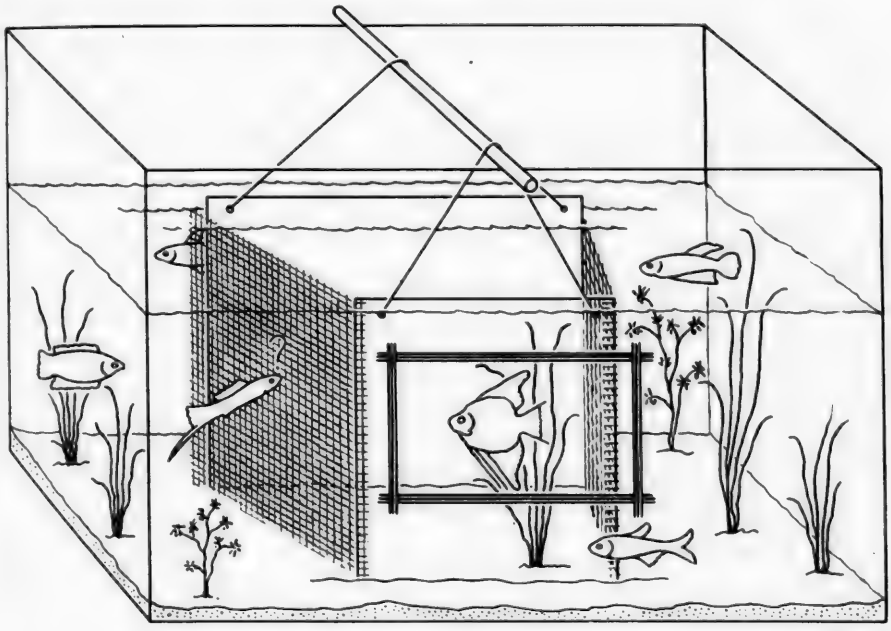
Arranging the Background. The retaining glass panel has holes in the upper corners (which can be drilled by most glass supply stores) for a picture-wire hanging. Since the glass was hung loosely on a stick, it could be moved closer to or farther away from the front glass of the tank so that fish of various sizes could be confined within the depth of field of the camera. The bottom edge of the panel was embedded in the gravel to prevent the fish from swimming under it.

Similarly, a larger, background panel was hung about six inches behind the retaining glass, the loose method of hanging again permitting changes in this distance for some variation in the amount of light on the background. A convenient background is another sheet of glass painted with a good grade of lacquer. However, opaque green glass or painted metal can be utilized. It even is possible to suspend a clear-lacquered underwater picture in the tank for special effects.

An aquatic plant of pleasing shape was then set in the gravel near the retaining glass. Two pieces of screen wire were next embedded in the gravel and rested against the edges of the hanging panels. This prevented fish from straying into the background enclosure, where they might appear, out of focus, in the picture. Of course, the level of the water was lowered to the top of the panels so that fish couldn't swim over their uppermost edges.

Arranging the Camera. The camera, a No. 33 Recomar, was affixed to a board bearing a flat-topped, wooden arch for getting at the tripod screw and for raising the camera to the level of the center of the tank.

The board was screwed to the bench in front of the tank. The camera was focused on a paper clip hung in the frame that the fish were to occupy. The field of view was then found by moving the edge of a white card across the front glass of the tank and its limits were marked on the front of the tank with tape. This taped frame served to indicate



to the photographer when the fish were in the field. A long, black-paper, lens hood was made for the lens. It was constructed so as to barely clear the field of view at the long bellows draw involved. With this shield it was possible to make the lamp-to-subject distance as small as is feasible. A regular lens hood is designed for the angle of view that exists at infinity and accordingly is not as suitable as an improvised one for this particular application. A black card for shielding the camera was then aligned with its hole in front of the lens and the hood pushed through the hole.

Locating the Lamp. A bare 60-watt house lamp was used temporarily to find the closest safe approach of the light source. It was placed three inches above the lens axis to produce a pleasing degree of top lighting. A large mirror was taped to the front of the tank and to the bench (on which the mirror rested) in such a position that it reflected

light back into the field. This was checked by placing a piece of white paper on the tank and watching the reflected illumination.

Finally, the flash gun was taped to a small bracket on the board in such a way that the Photoflash lamp took the position formerly occupied by the house lamp. The setup was then ready. All that was needed was an obliging fish to present itself in the field of view indicated by the taped frame.

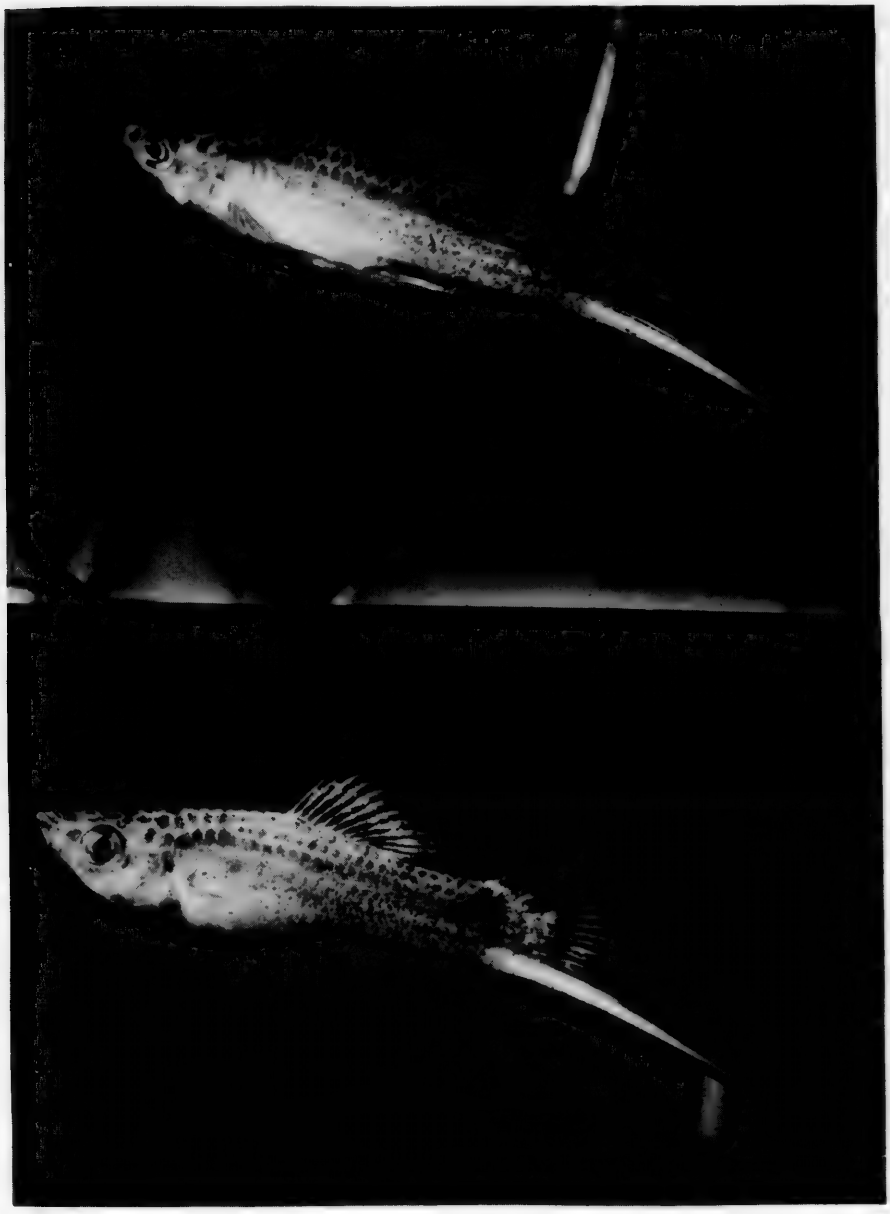
"Posing" the Fish

A statistician could no doubt arrive at the frequency with which any given fish would swim through the field of view with the fish having all the rest of the tank to cruise in. It probably wouldn't be very high. Nevertheless, there are some ways of fooling statisticians and influencing fish.

A small feeding ring should be constructed to fit between the retaining panel and the tank wall. The fish should be fed in this location for a few times previous to photographic operations. Then, if a feeding is omitted just before the photography, no difficulty will be encountered in obtaining subjects—merely tapping the glass with the finger will bring the hungry fish into the vicinity of the field. (Food should not be introduced during photography, because the water becomes spotty and cloudy).

It is also possible to make a guide or "persuader" for nervous fish who may not appear in the field frequently enough. An arc of acetate sheet, of the right width, can be embedded in the gravel between the retaining panel and the front glass of the tank with the top of the arc just approaching one of the lower corners of the field marked out with tape. Another strip of acetate sheet can be stood on end along the opposite edge of the field. Then, the fish is gently chased around the tank toward the arc. It either clears or swims up over the curve, encounters the invisible acetate wall at the other side, and backs up to consider the matter—right in the field.

The photographer should not make the exposure just because the fish is in the field. He should consider whether the "pose" is pleasing. As illustrated by the pictures of the red swordtail, it is better to have the fish pointed a trifle toward the camera than away from it. Again, the subject should not be photographed too close to the edges of the field. Finally, even though 1/200 of a second is a fast shutter speed, subject motion will appear if the fish is *darting* through the field at the time of the exposure. Fish often pause practically motionless in



the water, sinking slowly downward. The pectoral fins are then scarcely moving. For sharpest results, it is worth waiting for such a favorable pose.

Photographing the Entire Tank

It is sometimes desired to photograph an aquarium. This can be readily done, provided a few considerations are taken into account.

The most pleasing results are obtained when about three times as much illumination comes from the top as from the sides. The SM Photoflash lamp and an open flash technic can be employed. The method used for photographing the tank shown here will serve as a guide to individual technics.

Over this tank, which measures 14 x 14 x 32 inches, is a full sized, shiny, metal hood. This hood bears three lamp sockets for regularly providing light to the plants. For photography, SM Photoflash lamps were placed into these sockets for top illumination. Two other lamps in shiny reflectors were used, at camera level, to furnish front lighting through the face of the tank. They were located at 30 inches from the center of the tank face and checked, with substituted house lamps, for reflections. Each reflector was aimed at its own half of the tank. This setup permitted an aperture of f.11 with Kodachrome Film Type B. It was of course, necessary to prevent reflections of the camera and near-by light objects in the room from appearing in the front glass of the tank. This was done by shooting through a hole in a 30 x 40-inch black card supplemented with black cloth drapes over the tripod.

The exposure was made when the majority of the fish were fairly inactive. This was necessary, because, even at the small scale utilized, the exposure time was not short enough to "stop" the more rapidly swimming fish.

Tom Jones Named Honorary Member of BPA

When the B.P.A. met in Chicago in 1935, Mr. Jones, Professor of Medical Illustration at the University of Illinois, read a paper on "Design in Medical Illustrating". It was a pleasure to have him on our program again, and the members greatly appreciated his making the trip from Chicago to speak to us on "Post War Visual Education in Medicine". At the Friday morning sessions Mr. Louis Schmidt read the following motion:

"Because of his long and expert career as an artist in the service of the Medical Sciences, and as a teacher in that field: and because of his appreciation of the work of the Biological Photographic Association, his friendship for its members, and his broadminded acceptance of them as valuable co-workers in scientific illustration, this Association is proud to confer Honorary Membership on Professor Tom Jones of the College of Medicine, Dentistry and Pharmacy, University of Illinois, Chicago, Illinois, dean of medical artists in the United States."

The members showed their enthusiastic approval of this resolution by a rising vote.

Post War Visual Education In Medicine

by Tom Jones*

FOR several reasons I am glad of the opportunity to address you at this time but I'm afraid that some of these reasons are selfish. One of them might even be attributed to vanity because the other occasion when I appeared on your program was highly embarrassing. This was at your 1934 meeting in Chicago which caught me in that unhappy interval between the extraction of one's entire chewing equipment and their replacement by the ersatz kind. It's still a mystery why I attempted to talk to you under these conditions on "Design in Photography" or some such subject. At any rate you were very kind and none of you to this day has reminded me of it or ever mentioned that my mumblings on that occasion were quite unintelligible. Maybe it's just as well that they were.

Another reason, partly selfish, is that I wanted to attend this meeting and discuss with you some of the problems common to all of us engaged in the production of the graphic materials of medical education. It so happens that after forty years as a medical illustrator I find myself committed to a rather lengthy program of study and investigation in the broader field of visual education. More about this later. For the moment let's take a look at some of the factors which are shaping up the background of our future affairs.

As the war draws closer to an end we are all becoming concerned in what lies ahead of us. For we are beginning to realize that the dislocations of war are not just temporary changes but something deeper and more significant which mean that we are not going to resume our old life and old way of doing things after all. We suspect that some of these altered conditions are not only here to stay but that they presage still further changes in the years to come. Far sighted men in government, industry and science are aware that the old order is not going to return and they are trying to anticipate post-war conditions while planning a more sensible and stable world. For this can be said of war that it brings into sharp focus the mistakes of the past and despite its overall tragedy it forces us to realize the error of our ways and activates

* Professor of Medical Illustration, University of Illinois Colleges of Medicine and Dentistry. Presented at the Fourteenth Annual Convention of the Biological Photographic Association, September 7, 1944, at Binghamton, N. Y. Received for publication September 23, 1944.

us into doing something about it. It impels us to scrutinize the path we are traveling and to explore for new and better routes.

It can be said also that the demands war makes upon us for extraordinary effort bring out talents and capacities which we didn't know we possessed, and progress in many fields is stepped up to a remarkable degree. It is probably safe to say that under the driving lash of grim necessity we have telescoped into a few short years the progress expectancy of several decades in normal times. As a result, millions of adults living today will enjoy the benefits of these war-time developments and inventions which in times of peace would have been reserved for the generation which follows us.

Ranking high among things which have taken forward strides in the last few years is visual education. Less dramatic than the building of planes and ships it is far reaching in its consequences. The manufacture of armaments and materials of war will slow down and cease but the production and use of the visual aids to understanding and knowledge will continue with an ever-increasing tempo.

Teachers and educators everywhere are in agreement on this. Certainly in the fields of medicine and the biological sciences more and more emphasis is being placed on visual avenues of learning. It is the obvious and maybe the only immediate answer to the problem of the overcrowded curricula which has bedeviled administrators and faculties of our teaching institutions from time immemorial. These teaching schedules which have had to operate within a fixed time limit have always been based largely on the lecture system which in turn is predicated upon the idea that a given subject can be taught if a sufficient number of hours can be found to talk about it to (or at) the students.

We are developing a new approach to this whole question and it is quite possible that the time will come when formal education will be appraised by entirely different standards. The yard stick of education may not be the amount of time the student was exposed to his subject as represented by credit hours but the kind of teaching he had. We are becoming skeptical of some of the established theories and technics of classroom teaching and it is being suggested that quality and effectiveness might better be measured by some formula which takes into consideration the total amount of time spent to produce a given result.

The whole problem is, after all, a matter of how best can knowledge be communicated with the three tools we have to work with—the spoken word, the written word, and visual media. Singly or in combination they must be used according to the nature of the job to be done. Each has its peculiar and inherent qualities not possessed by the other two.

It seems to me that we have not fully understood this. If we have, we have lacked the boldness to act upon it, for precedent and tradition are strong and progress has ever had an uphill battle against them. A striking example of what can be accomplished by an intelligent and independent educational program is furnished by the Army and Navy. The story of how they trained several million men in a wide variety of technical services in a minimum of time by utilizing visual methods is known to you all. I will only add that the brilliant results obtained by their streamlined and highly efficient teaching program are being widely discussed in teaching circles. We can be pretty sure that this is one lesson war has taught us that will be reflected in the educational pattern of the future.

Recently in a discussion with Dr. Eben J. Carey, now Dean of Marquette Medical School, and an authority on visual education, I asked the question I've asked many others, i.e., What are the most valuable aids to modern medical teaching in their order of importance? His reply was very interesting. He said in substance that life itself or demonstration on the living object came first, then the visual material which gave the illusion of life and reality and was understandable, convincing and best adapted to the subject, time and place. It was a thoughtful answer and implied more than it said. Maybe it subconsciously decided me against discussing here as originally planned the merits and limitations of the various kinds of aids and graphic materials which constitute the machinery of visual education.

I was tempted to talk about lantern slides and projection methods, about transparent models, and that most glamorous member of the visual family, the motion picture. Speculation about the future development of these things is interesting but time does not permit it here.

I would like to say a word, however, about the most important of all visual media, the illustration, because it is not only the most widely used of all graphic materials, it is the routine and day by day concern of photographer and artist alike. There are in America about 75 artists and probably well over 1000 photographers who specialize in the general field of medicine, biology, dentistry and public health. At a guess I would say that 90% of their collective time is employed in making some form of still pictures. Many, indeed most of the artists drawings, and an even greater number of photographs will find their way into print. They will become the illustrations now so important to medical literature that without them the publication of journals and books would shrink markedly and medical progress would be appreciably retarded. This is not an overstatement, I assure you. It is a fact which all of us need to be reminded of from time to time in order that we won't lose sight of the responsibility which our work entails. Make no mistake

about this. It is a truth worthy to be carved over the door of our studios lest we forget that the pictures we produce are something more than a routine record of the amount. Some of them will in due time appear in the pages of a book or journal article, others will become lantern slides or part of an exhibit. However utilized they become part of the stream of communication of knowledge carrying their message silently and efficiently to thousands who will learn and be guided by them.

Higher standards in scientific photography prevail today than ever before. As *photography* much of it is excellent. As illustration, however, some of it is unworthy of the name. I intend to speak bluntly on this point because, having studied it from this angle for a long time, I know it to be important. I know also that something can be done about it. It only requires the realization that an illustration is something which must illustrate. It's as simple as that provided we go on from there and consciously and deliberately work to that end. I sometimes wonder if the technical aspects of the photographers' profession and the chemical and optical standards he works by have not obscured this. It is not enough to produce a photograph sharply focused, properly developed and well lighted. It may have the correct background and all the conventional qualities and still fall short of the mark. To be a good scientific illustration it must have design and character, it must tell its story quickly, truthfully and convincingly. It must have conscious aim and purpose. In short, it must illustrate.

Just why do we make a photograpah of, let us say, a fresh specimen? It is because that specimen has a peculiar quality or character that makes it different or significant in some way. It may be a tumor of unusual size, shape, color or texture. Its particular character, whatever it may be, is the reason and the only reason it is being photographed. Unless the result we get clearly captures this peculiar quality we have failed.

Let's take a very simple case of an ovarian cyst of huge size. The photograph of this specimen should give an immediate impression of size about all else. No one is interested in its texture, shape or color; these are not the characteristic things and they are altogether secondary in importance. If the reader of a medical journal encounters this illustration and is conscious of an enormous tumor the moment his eyes fall upon the half-tone, he is impressed and interested. If the usual type of photograph is used and he sees a picture of some kind of specimen which requires the reading of a legend to mean anything the chances are pretty good that he gives it a passing glance and turns the page. Don't think that placing a centimeter scale along the bottom is going to make up for the lack of design and thought. It isn't. The kind of photography I'm talking about is practical in any studio and

requires no special apparatus or tricks. It requires only a knowledge of certain laws of design and composition plus a bit of experimentation. In the case of our hypothetical cyst, for instance, the size would be emphasized in several ways; the most common is by comparison to other objects such as instruments and hands. A nurse might hold the tumor in such a way that she would not obtrude. Another device to emphasize size is to allow the specimen to fill the picture, leaving little background. Neutral or soft backgrounds recede and sometimes make the object appear larger while black and pure white ones tend to come forward and emphasize contours, and so forth. Using these and other principles common to pictorial art, plus ingenuity, objects can be made to look small or large, soft or hard, transparent or opaque, etc.

Let's be perfectly clear about this. It is no impractical esthetic notion unsuited to busy studio practice. It is an obvious and necessary attribute of good scientific photography which is pretty generally overlooked.

A good thing to remember is that an illustration, whether it be drawing or photograph, has a job to do. When it leaves our hands it must go to work. It is on its own and the only thing that counts is how clearly and quickly it can tell its story or convey its particular message. *How* we put this quality into our work is of no interest to anyone but ourselves and our technical achievements are of no consequence whatever except that they contribute to this end.

I wish there was time to discuss with you some phases of our work which editors and publishers talk to me about. No one knows better than they the importance of good illustrations and no one does more to promote them. In this connection the recent appointment of W. C. Shepard, well-known medical illustrator, as Art Editor of the W. B. Saunders Company, should be of interest to us all. Through years of contact with publishers and their picture problems I have learned a good deal about illustrations from the standpoint of the ultimate consumer. Things we do not ordinarily think of in our more or less cloistered studios. If the editors were to express themselves here I think they would endorse wholeheartedly what I said about design in photographic illustrations. They would probably take the opportunity to mention some other things which worry them and, which to hear them tell it, brings on gray hairs and an untimely end. (This last I've always doubted because they are a healthy looking lot and they never seem to die.) They would ask us to please send in for publication only prints suitable for reproduction,—that is, prints which are not too dark and not too light, of a good size and on glossy paper if possible. They would try to show us how detail is sometimes lost through the half-tone process of engraving and so to insure a good printed result, copy should

be sharp and clear. They want prints (but not x-rays) retouched if necessary to make good illustrations of them and they want clean readable labels (not the kind done with the author's fountain pen.) I think that they would ask you to discourage the practice of sending in a photographic print of a graph, chart or drawing when the original is available. Often the author is reluctant for some reason to do this but except in special cases a more satifactory result is obtained if the engraving is made from the artist's original.

Perhaps the fastest growing medium of visual education in medicine next to motion pictures is exhibits. It seems to me that artists and photographers are spending more and more time each year on display material and in some quarters such as our studios at Illinois the period preceding the May and June meetings is a nightmare of activity. The popularity of exhibits has grown to a point now where they are the Number One attraction at the annual convention of the American Medical Association and Doctor Hull, Director of Exhibits, told me last week that they are planning to photograph a considerable number of them each year and bring them out in some form of brochure or booklet for distribution. All this means, of course, that there will be an increasing demand for natural color photography and all manner of enlargements, drawing, and other graphic materials. Scientific exhibits have become big business and we will need all of our ingenuity and inventiveness to keep up with the parade to say nothing of leading it in the right direction.

Earlier in this paper I referred to finding myself embarked upon a program of inquiry into visual education. It came about through the generosity of a great surgeon who established at the University of Illnois a sizeable fund to finance a nation-wide survey of this whole subject. The chief objective of the program is a comprehensive analysis and study of visual avenues in medical education based upon the thought and practices in the representative teaching instituions over the country. We hope to find out many things that we do not know now—from the psychological foundation of visual media to the how, when and where of their use. The program has other aims also which it would be premature to discuss at this time. Perhaps it is enough to say here that its overall purpose is to promote, through better understanding of the visual pathways of knowledge, the broad interests of medical education.

Determination of Exposure in Kodachrome Photomicrography

R. P. Loveland*

FOR the determination of exposure in Kodachrome photomicrography there are two important advantages not available for the estimation of exposure in ordinary photography. First, the most reliable criterion for the correct exposure for reversal materials, such as Kodachrome film, is the brightness of a field element located within the high brightness region. In photomicrography by transmitted illumination, the brightest area is unequivocably the unobstructed bright field itself with the lightest detail frequently forming a lightly contrasting lacelike pattern against it. Second, at least the "highlight illumination" in the plane of the film itself can usually be measured directly, or calculated very simply from a measurement made at shorter bellows length.

Exposure Comparisons for Reversal Materials

For discussion of the first advantage let us consider two negatives made on the same film material, correctly exposed and identically developed. The densities, or photographic tones, obtained on the various areas of these negatives can be plotted against the amount of the exposure (actually against the logarithm of the exposure) that produced them; the results will lie along a characteristic curve in each case as shown at the top of figure 1. A familiar rule for exposing negatives has always been "Expose for the shadows and let the highlights take care of themselves." This means that if the subjects of the two negatives had different ranges of brightness, AB and CD, respectively, the films would have been so exposed that there would be just adequate density differences at the minimum density limits of the negatives to show the darkest detail; that is, the dark limits, A and C, of the brightness range of the two subjects have the same density on the two negatives. The density of the brightest areas of the subjects need not be considered, as indicated in the rule; their densities and the relative positions of their representation, B and D, on the graph depend entirely upon the range of brightness of the subjects. Now consider positive transparencies, such as lantern slides, made from the negatives of these two subjects. Here, of course, the photographic densities diminish as the original

* Kodak Research Laboratories. Communication No. 999. Received for publication November 3, 1944.

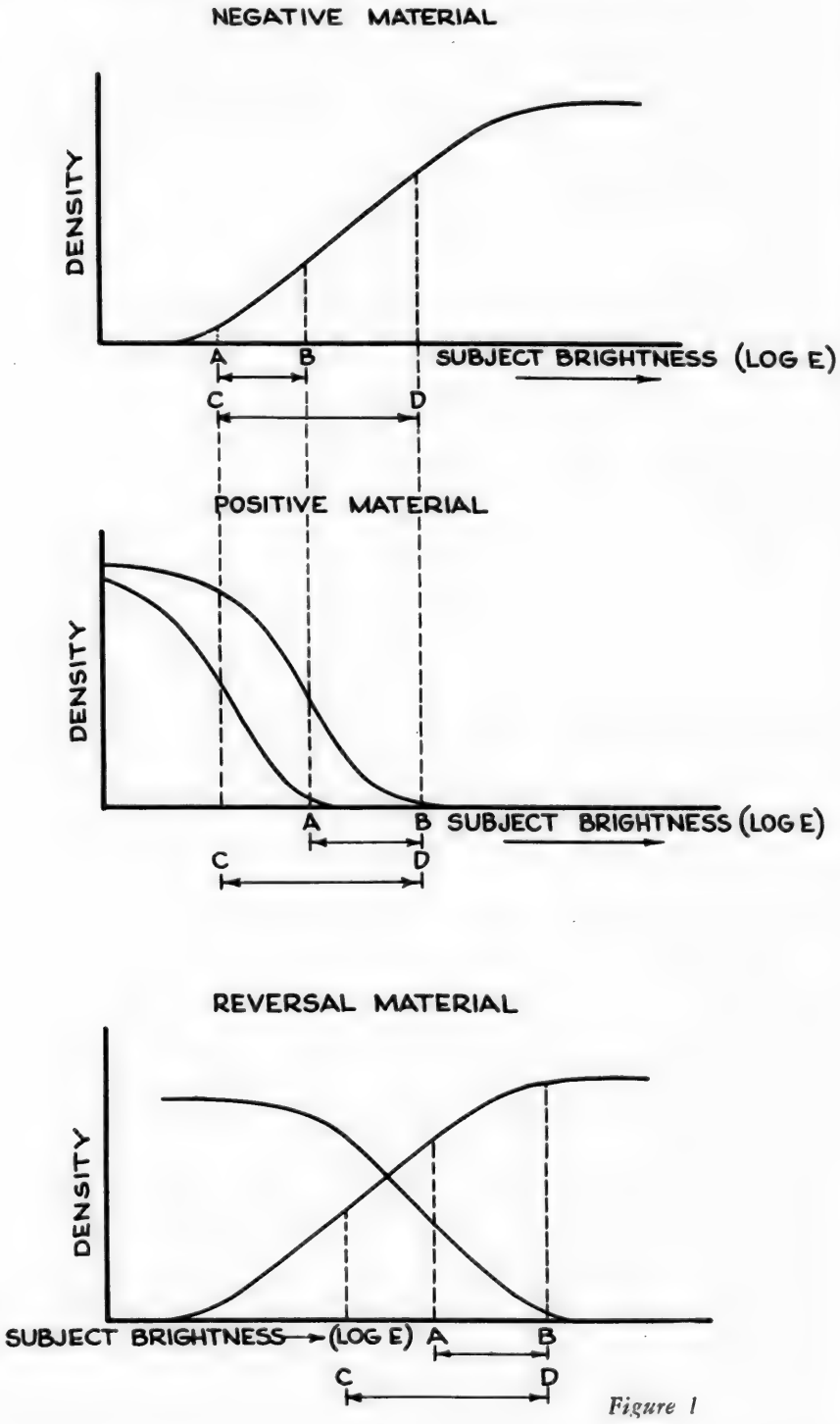

NEGATIVE MATERIAL
DENSITY
A
B
C
D
SUBJECT BRIGHTNESS (LOG E)
POSITIVE MATERIAL
DENSITY
A
B
C
D
SUBJECT BRIGHTNESS (LOG E)
REVERSAL MATERIAL
DENSITY
SUBJECT BRIGHTNESS → (LOG E)
A
B
C
D

Figure 1

brightness of the subject increases. Since "whites should look white" in the pictures, the brightest portions of the subjects are printed so that their upper limits of brightness, B and D, respectively, both have a very low density that will, however, show the detail. This must be done in printing, by adjusting the exposure of the positive to the range of the subject on the negative. This is shown by the middle graph where it can be seen that the highlights of the two pictures, B and D, have the same density but that this is no longer true of the shadow density limits, A and C.

However, in all reversal processes for color pictures, the negative silver image is dissolved away, and the residual silver halide is converted into the positive colored image; that is, the relation between the negative and its positive is relatively fixed, as indicated in the lowest portion of figure 1. Since this material is expected to produce positives without muddy whites, it must be exposed in the camera as if it were being used for making a print; that is, in general, the *highest light in which we wish detail* determines the exposure. Therefore, to utilize the positive reversal curve the film cannot be exposed as a negative. It is evident why positive and negative materials can only be compared when the brightness range of the subject is considered. This question frequently arises when the correct exposure time for making a Kodachrome photomicrograph is desired by individuals experienced in ordinary photomicrography.

Simplicity of Exposure Variables in This Case

The fact that for reversal processes the brightest portion of the camera image contains the criterion for the determination of the correct exposure makes the determination of exposure for Kodachrome film a much simpler matter than it is for negatives, especially in photomicrography. In thin sections taken by transparent light, the brightest portion of the field is always the unobstructed bright field itself. Therefore, the practical procedure is obvious: Rack the specimen out of the field entirely and photometer the brightness of this field. With reflected nonspecular illumination, a white card or paper can be substituted for the object or merely used to cover it during the exposure determination.

This leads to the second advantage possessed by the photomicrographer, namely, the simplification that results from the fact that the image plane is available for measurement of the light actually incident on the film. Therefore, the many extraneous factors involved in exposure determination in general photography, such as determination of "effective f. value", effect of the angle of lighting, relative areas of light and shade, etc., are of no concern here. With reversal materials, there are two factors: the speed of the film and the highlight illumination.

Any practical method for the determination of the brightness of the field can be utilized. It is sometimes forgotten that photomicrographs are usually made under conditions in which devices and methods are practicable that cannot even be considered in general photography.

Visual Photometers

One of these devices is the visual photometer. In the type of instrument suitable for the present purpose, a small area of a diffusing surface placed in the image plane, where it would be illuminated by the light of the camera field by transmission, is seen simultaneously with another diffusing surface, by means of some beam-splitting device. This comparison surface is illuminated by a lamp whose brightness can then be varied until the two areas appear to be of uniform brightness. Such a visual instrument is not to be despised; with it the brightness of very small areas can be determined so that it is normally not necessary to remove the specimen. Moreover, it is usually possible to measure the highlight illumination in the image plane throughout the intensity range encountered in making most photomicrographs. Commercial instruments of this type can be purchased. Such an instrument can be made without undue difficulty, if desired. The description and design for making a very simple but practical visual photometer with the minimum of optical parts is given in the appendix. Other types are described by Walsh[1] who also gives an excellent discussion of the principles and technics of photometry.

Photoelectric Photometers

Illumination can be measured very conveniently with a photoelectric cell, especially one of the stable barrier-layer type, when the intensity lies within the range in which these cells are applicable. Often in color photomicrography, it is worth while to utilize a light source that will provide illumination at a level where a photoelectric photometer can be used, either in the image plane or nearer the eyepiece, and this can usually be done in making transparencies. Frequently, especially in relatively low-power work, the recent types of the ubiquitous hand exposure-meter, utilizing the barrier-layer type photocell, are sufficiently sensitive. In photomicrography, however, a sensitive wall-type of galvanometer with this type of cell is a perfectly practical combination, or even a somewhat bulky and sensitive amplifying unit with an emission type of photocell, and such advantages of the situation should not be overlooked, as mentioned on this page. Both photoelectric cell-galvanometer combinations have already been recommended[2] for photomicrography.

[1] J. W. T. Walsh "Photometry," Constable and Co., London, 1925.

[2] L. Gross and C. A. Johnson, This Journal *1* June, 1933), 172-92, W. R. Earle, Ibid., 7 (December, 1938), 54. H. M. Hefley and A. I. Smith, Ibid., *10* (June, 1942), 165.

Both of these combinations are available commercially as "illumination meters." With the barrier-layer cell, a sensitive semiportable galvanometer is used that is calibrated directly in foot-candles. The minimum single scale unit is 0.05 foot-candle, but since such a deflection hardly constitutes a reliable measurement, a minimum sensitivity of 0.1 foot-candle can be assumed. As highlight illumination in the image plane, this corresponds to an exposure of about 2 seconds with Kodachrome Film, Type B. Since the response of such photocells is proportional to their area, commercial units are offered with a multiple group of cells to increase the sensitivity, but such instruments are not generally useful for photomicrography, because of the large uniformly illuminated area required.

Because of the high sensitivity of the photometers utilizing amplification (at present about 0.0001 foot-candle per minimum unit of the scale with white light and with the full cell aperture), the measuring aperture of the unit can be reduced to a diameter of a few millimeters for many of the exposure determinations, which is frequently a great advantage. At present, the galvanometers of these instruments have only a relative scale which must be calibrated at the time, with the aid of an independent light source. Operation of these instruments is somewhat more time-consuming than is that of the direct-reading type, and it is not possible to change quickly and conveniently from measurements at one light intensity to those of another differing by an intensity factor of 100 or more; in fact measurements at intensity levels, corresponding to most of the scale readings of a hand exposure-meter, are neither convenient nor reliable. For this reason, it is best to use an amplification photometer augmented by a barrier-layer type for the higher intensities of low-power, transmitted illumination, etc. Since this is so, and since their ranges overlap, advantage can be taken of these facts for the simple calibration of the more sensitive instruments. As in the case with the visual photometer, it is only necessary to illuminate a plane, preferably containing a sheet of clean glass, by any temporary expedient that gives a uniform illumination within the mutual range of the two instruments. The illumination should be read by the hand meter in foot-candles, or in its arbitrary units, then read with the other meter and its scale set, and finally rechecked for constancy with the hand meter.

The illumination, of course, may be too low for any type of photoelectric meter as it often is in the case of fluorescence or illumination through crossed polarizers; both cases are of importance for color photography. The exposure should then be determined by an exposure-development test.

THE COLOR-TEMPERATURE FACTOR IN EXPOSURE DETERMINATION BY PHOTOMETRY

The use of photoelectric photometers introduces another complication so that the limitations involved in the measurements and in the distinctions of the terminology must be clearly recognized.

As is well known, when the color temperature of a lamp is changed, the fraction of its total radiant energy that is visibly perceived as *illumination* will also change. By definition and long usage only the visual fraction is included by illumination terms, such as foot-candle. Unless a photoelectric cell has a filter that changes its response to make it identical with that of the human eye, a change of color temperature may not affect it in the same manner. Most photoelectric-cell illumination or exposure meters are calibrated to agree with visual determinations of illumination at a color temperature of 2700°K. According to a curve published by the Weston Electric Instrument Company[3], the measurement with their Type II cells would then be about 8½ per cent too high at 3500°K and about 5 per cent too high at 3200°K. This is apparently approximately correct for the barrier-layer cells in the commercial exposure meters of the other makes.

The fact that even the spectral sensitivity of panchromatic and color films is not the same as that of the eye adds another complicating variable. This is well known but should be kept in mind whenever the speed of a film is considered for a color temperature or illumination quality different from that with which it is generally used. This includes the presence of filters in the illumination beam, which is so frequent in color photomicrography; imperfect photometric filters of strong conversion power, ultraviolet, and color-compensating filters will affect the photometric-photographic sensitivity ratio to some extent.

It is fortunate for this purpose, however, that the spectral sensitivity of the barrier-layer type of photocell is more like that of photographic color film than either is like that of the eye. As a result, when the illumination quality is changed by color filters of broad absorption characteristics, the optimum exposure for the film, as measured in foot-candle-seconds by such a photometer may be practically unchanged even though the time of exposure is lengthened by an appreciable filter factor. For instance, the optimum exposure of Kodachrome Film, Type A, was practically unchanged when measured by such a photocell and then checked with the color film when the normal tungsten illumination at 3450°K was replaced by one in which a Wratten No. 1 Filter was used to absorb ultraviolet and a blue liquid compensation filter[4] was

[3] "Technical Data on Weston Photoelectric Cells." Bulletin 18A, 1938.

[4] R. P. Loveland, "Kodachrome Photomicrography of Stained Slides," This Journal, *12*, (June, 1944), p. 143.

used to recompensate the color balance, or when this was replaced by the illumination from a 5-ampere arc with a 10-mm. layer of 2 per cent sodium nitrite solution to remove the excess ultraviolet.

The complications discussed here are usually not considered in photography at all, and need not be when the speed of a given film is always considered for use at approximately the same color temperature. In photomicrography, the illumination required for any film should be specifically determined for the illumination used by a standard exposure development test as described later, especially if there are filters in the system.

Procedure for the Use of Photoelectric Meters

Directions for the use of photoelectric exposure meters in photomicrography are sometimes more complicated than need be. It can be assumed that the current from the photoelectric cell is directly proportional to the incident illumination, *if a constant area* of the sensitive cell *is entirely and uniformly covered.* The only factor to be considered, therefore, when the illumination in the image plane can be measured, is the current through the meter. When possible, the illumination is read in the image plane, with the ground glass removed or replaced with a clean piece of clear glass and the subject racked out of the field, or replaced with a white card when nonspecular (e.g., oblique) illumination is being used. If the illumination is too low for this procedure, the photometer should be moved toward the eyepiece to take advantage of the resulting rapid increase in intensity. From this measurement, the illumination in the image plane should be calculated, which can readily be done as explained below; its value in absolute units such as foot-candles is unnecessary though convenient.

There are two methods that can be used for the measurement of the illumination nearer the microscope and the subsequent calculation of its value in the image plane, both depending upon the illumination forming a cone of light with its apex at the exit pupil (eyepoint) of the microscope and its base in the image plane, while the measurement is made at an intermediate parallel plane. One method utilizes the fact that the ratio of the intensities in these two planes is inversely proportional to the square of the diameters of the illuminated fields, the diameter of the smaller measured field being held constant. Maurer[5] has developed this method, ingeniously determining the fixed diameter of measurement as that which *just* subtends the photocell.

The other method depends upon the ratio of the intensities in the two planes as determined by their distances from the apex of the

[5] J. A. Mauer, "Exposure Control in Photomicrography," This Journal, *12,* (June, 1944), p. 173.

illumination cone; the latter distance is, of course, the bellows length and is frequently easier to measure than the diameter of the illuminated field in the image plane. For this method, the photocell should always be held at some predetermined position along the bench where the diameter of the illuminated field is definitely of somewhat greater diameter, so that it more than covers the cell.

A number of simple prearranged devices materially reduce both the time and the work of measuring the two distances. It is worth while having a scale, such as a yard or a meter stick, along the bench or rod extending from the microscope beyond the back of the camera, with a pointer to denote the position of the ground glass. Most horizontal optical benches already have a scale on them. If there is a short distance on the scale between the pointer and the intersection of the plane of the ground glass with the scale, this value should be determined and posted. A very simple wooden right angle, bearing a white card parallel with the image plane, can be used to determine quickly the scale position of the zero point of the illumination cone which is the exit pupil or eyepoint. The right angle with its white card is shoved up toward the eyepiece until the light spot on it is the minimum size, and the scale position is read from the base of the angle. With a simple microscope, such as a Micro-Tessar, the zero point is in the objective. With the negative amplifiers, such as the Homals and Ampliplans, the "eyepoint" lies well within the microscope. The scale reading corresponding to the mechanical end of the eyepiece can quickly be determined by shoving the wooden right angle up against it; then the scale position of the zero point is determined by adding the constant distance associated with each Homal or Ampliplan, which also should be posted. The latter is easily ascertained, once for all, with an appropriate objective, a stage micrometer, and the Homal or Ampliplan in question, by plotting various magnifications against the scale positions of the ground glass, since the scale position of the zero point can be read from the graph and subtracted from the position of the mechanical end of the ocular. The bellows length is, of course, the true position of the ground glass minus the true position of the zero point.

The distance of the sensitive cell from the zero point is best determined directly by moving it toward the eyepiece until it is in contact with the edge of a card that is serving as a spacer between the end of the ocular or the eyepoint and the correct photometer position. The length of the card, which is withdrawn during the actual light measurement, is equal to the appropriate distance of the sensitive cell from the zero position, plus or minus the distance of the mechanical end of the ocular from the eyepoint. The proper factor for multiplying the illumination in this plane to allow for its distance from the eyepoint should

be recorded on each card. Distances for this photometer surface *from the zero point* that give particularly simple multiplying factors are given in the first column of Table I. Usually, it is best to select the

TABLE I

Distance of Photometer		Scale Units	Factor
3⅛	inches	inches	0.1
10	centimeters	centimeters	1.0
4½	inches	inches	0.2
14.14	centimeters	centimeters	2.0
5½	inches	inches	0.3
17.32	centimeters	centimeters	3.0
7-1/16	inches	inches	0.5
22.36	centimeters	centimeters	5.0
10.	inches	inches	1.0

Example: Assume that the illuminance is 8 foot-candles when measured at 14.14 cm. from the eyepiece and that the bellows length is 56. cm. Then,

$$8 \times 2 \times 0.0319 = 0.51 \text{ foot-candle}$$

is the illumination in the image plane.

shortest distance with which the disk of illumination is larger than the cell surface. Although a small set of these cards for different oculars is a great convenience and speeds up the measurement, obviously it is not necessary for the measurement of the illumination at a definite short distance from the eyepoint.

The value of the illumination measured close to the eyepiece by the photometer, *multiplied* by the square of its distance from the eyepoint and *divided* by the square of the bellows length, equals that in the image plane. In practice, the latter value can quickly be calculated as follows: *Multiply the photometer reading by the factor in Table I, corresponding to the distance of the photometer from the eyepoint, and also by the factor in Table II, corresponding to the distance of the ground glass from the same point, in order to obtain the illumination in the image plane.* The unit values of Table II are probably sufficiently accurate for the determination of the photographic exposure; intermediate values can be obtained by the usual processes of interpolation; interpolation between values of $n = 1$ and $n = 10$ can be obtained by multiplying the *factors* of the rest of the table by 100 but dividing the values of n by 10. The factors in Table I are the squares of the photometer distance divided by 100, while the factors of Table II are the reciprocals of the squares of the bellows lengths multiplied by 100. It is obvious that Table II can also be used to calculate the highlight illumination in the image plane by the first method, where the distances (first columns) are the diameters of the illuminated field

TABLE II

Values of $1/n^2$ Multiplied by 100

n	Factor	n	Factor	n	Factor	n	Factor
1	100.000	26	0.1479	51	0.0385	76	0.0173
2	25.000	27	0.1372	52	0.0370	77	0.0169
3	11.111	28	0.1276	53	0.0356	78	0.0164
4	6.250	29	0.1189	54	0.0343	79	0.0160
5	4.000	30	0.1111	55	0.0331	80	0.0156
6	2.778	31	0.1041	56	0.0319	81	0.0152
7	2.041	32	0.0977	57	0.0308	82	0.0149
8	1.563	33	0.0918	58	0.0297	83	0.0145
9	1.235	34	0.0865	59	0.0287	84	0.0142
10	1.000	35	0.0816	60	0.0278	85	0.0138
11	0.826	36	0.0772	61	0.0269	86	0.0135
12	0.694	37	0.0730	62	0.0260	87	0.0132
13	0.592	38	0.0693	63	0.0252	88	0.0129
14	0.510	39	0.0657	64	0.0244	89	0.0126
15	0.444	40	0.0625	65	0.0237	90	0.0123
16	0.397	41	0.0595	66	0.0230	91	0.0121
17	0.346	42	0.0567	67	0.0223	92	0.0118
18	0.309	43	0.0541	68	0.0216	93	0.0116
19	0.277	44	0.0517	69	0.0210	94	0.0113
20	0.250	45	0.0494	70	0.0204	95	0.0111
21	0.227	46	0.0473	71	0.0198	96	0.0109
22	0.207	47	0.0453	72	0.0193	97	0.0106
23	0.189	48	0.0434	73	0.0188	98	0.0104
24	0.174	49	0.0417	74	0.0183	99	0.0102
25	0.160	50	0.0400	75	0.0178	100	0.0100

in the image plane which is to be *multiplied* by the diameter of the beam that *just* subtends the photometer cell. In this case, to place the decimal point correctly, the values of Table II should be divided by 100.

Calculation of the Exposure Time from Illumination Value

When the illumination in foot-candles in the image plane of the clear background of a transparent specimen, such as a thin section, is known, calculation of the correct exposure time for Kodachrome film is very simple, since:

$$\text{Correct Exposure} = \text{Illumination} \times \text{Time of Exposure} =$$

$$E_c = I \cdot t \qquad (1)$$

$$t = E_c / I \text{ seconds} \qquad (2)$$

For Kodachrome Professional Film, Type B, the value of E_c is about 0.25 foot-candle-second for a photomicrographic transparency; this should produce a small density in the background area so that no detail will be burned out. For Kodachrome Film, Type A, the value of E_c is about 0.15 foot-candle-second for a photomicrographic transparency, such as a thin section, as measured by a photoelectric photometer of the usual exposure-meter type. These values will probably not be materially altered by the usual photometric and compensating filters when the illumination is measured with a barrier-layer type of photocell.

As will be discussed later, these values of E_c may be considered to be the *basic minimum exposure* for transparent illumination; they are also the values most frequently useful.

The illumination in foot-candles is available to practically all users of commercial illumination meters, as previously discussed. When the hood is removed, the General Electric hand exposure-meter gives the measure in foot-candles.*

The Weston hand exposure-meters, such as the Weston Master, are calibrated only for brightness measurements in candles per square foot, for pointing the meter directly at the subject in the field or a studio, so the "acceptance angle" of the meter is an included factor. It is simplest to include this instrument in the general case where a photocell is connected with any sensitive meter with an arbitrary scale, except that the calculator dials on the back are useful, as described below.

In this general case, the relationship is:

$$E_c = I \cdot t = K/S, \text{ where } S = \text{Film speed}; \qquad (3)$$

$$t = \frac{K}{I \cdot S} \qquad (4)$$

* The meters are correct at 2700°K. See page 84.

The proportionality constant, K, need never be known; in fact, both the illumination and speed values need only be in some arbitrary but consistent units.

The instrument and the method of photometry are simply calibrated at once for all of the factors in the individual situation by making an independent determination of the correct exposure, as will be explained under *Exposure-Development Tests,* merely keeping account of the highlight illumination values. If the correct exposure $I \cdot t$, is known for a single case, a graph can be plotted of t *vs.* I, since K/S can be considered equal to this constant over the range for which this frequently assumed reciprocity law (3) is useful. If the plot is drawn on Codex log-log graph paper No. 4123, this relation is represented by a straight line which simplifies both the drawing and the use of the plotted values.

If either the Weston Universal or Master Exposure Meter is being used, then, after the original photographic determination mentioned has been made, the calculator dial can be utilized to determine any further exposure times, t, without further ado, by the following procedure.

Set the red dial for the correct film speed as usual. For Kodachrome Film, Type B, under illumination at 3200°K, this would be a setting of 6, which is the Weston exposure setting. On the top dial, all that would be needed for photomicrography would be two arrows, one to be set at the illumination reading and one, near the opposite side of the dial, to point to the correct exposure time. The first arrow is already there, and hence the second step is to set it opposite the illumination reading as usual. The opposite side of this dial is occupied by the series of f. numbers not used in this procedure. Another arrow could be marked on the dial with the aid of a piece of tape but the simplest method is merely to select the proper one of these f. values to represent the missing arrow and to record the number. This is done, of course, by choosing the value as a marker that is opposite the correct exposure time when the rest of the calculator is set up to conform with the exposure conditions of the picture of optimum quality on an independently exposed test film.

Consideration of the Specimen as an Exposure Factor

If the photographic reversal film had a sufficient latitude of correct reproduction to represent the tone range of all transparent specimens, and if the illumination used in viewing the finished transparencies were always adequately bright, there would be no further factors to be considered in the exposure determinations for Kodachrome photomicrographs. As it is, the specimen must be taken into account in some cases.

Let us consider first a specimen illuminated by transmitted light with some clear background but having large dark areas which are of the greatest interest (e.g., a thick botanical section). Obviously, the wisest procedure is to increase the exposure time over that of the basic minimum exposure and to sacrifice deliberately the detail in any light and thin areas by "burning them out" to bring the darker areas to a reasonable level of transparency in the Kodachrome photomicrographs.

In the cases where there are no areas that appear clear in transmitted light or white in reflected light, there is no obvious sacrifice of light detail in increasing the exposure until the principal areas are sufficiently transparent in the Kodachrome picture. Whereas a good guess of the necessary exposure increase over the basic exposure can frequently be made, in doubtful cases, and exposure-development control test should be made as described in the next paragraph. Where many such specimens occur, a separate exposure-test standard should be set up and the increase over the basic minimum exposure determined.

Exposure-Development Tests and Standards

In photomicrography, a preliminary step exposure-development test insures an exactly correct exposure in a subsequent picture. In color photography, excellent results are particularly dependent upon correct exposure. If complete photometry of the illumination in the film plane is being consistently practiced, as previously described, a few step exposures to Kodachrome film of several typical specimens may be sufficient for calibration. It is very worth while, however, to make an exposure-development test when there is any doubt as to the best choice of exposure; this sometimes reveals other faults also. For this preliminary test, the use of the less expensive black-and-white material is usually desirable.

From the discussion on page 81, it is evident that it is foolish to use a preliminary exposure-development test of one of the familiar photomicrographic negative materials, such as an "M" plate, to determine the correct exposure. Black-and-white reversal materials are available, however, which are quite satisfactory for this purpose. Experience has shown that the selection of the proper exposure step for the color picture directly from a black-and-white test strip is not easy, particularly if there is a difference in contrast or latitude between this material and the Kodachrome film, *unless some actual comparison standard is available.* This criterion is furnished by a standard composed of a series of exposure steps made on both Kodachrome and the black-and-white material to the same microscope field and mounted or held, side by side. It is then possible to estimate, from a preliminary black-and-white step test of some new field, what it would look like in color as a Kodachrome

film, by comparing it first with the black-and-white standard and then with the corresponding step of the Kodachrome film. Where considerable Kodachrome photomicrography is to be done, it is certainly advisable to set up some of these exposure standards, one set for each very different type of subject or illumination. For one person, only a few standards are usually required. Where no photometer is used, this procedure is almost a necessity for consistently excellent results.

Where Kodachrome Professional Sheet Film, either Daylight Type or Type B, is being used, Kodak Super Speed Direct Positive Paper is suitable for the black-and-white control, since the processing of this material is simple and rapid. It is necessary, however, to remember that it is highly green- but not red-sensitive, so that areas stained with red will appear relatively underexposed.

Kodak Direct Positive Panchromatic Film furnishes the suitable reversal material for a comparison standard when Kodachrome Film, Type A, is used. A developing outfit may be purchased for processing this film, which contains complete directions. A mimeographed sheet of formulas and directions is available for those who prefer to compound their own solutions. Where a reversal material is used as an exposure standard, it must be borne in mind that variations in time, agitation, or temperature during the first development will probably show in the results as *variations in the speed of the film.* Therefore, the permissible variations in development time indicated in the direction sheets for general pictorial work cannot be tolerated for this purpose. For tank development, eleven minutes at 68°F. should be adopted. On the other hand, short strips of this film (e.g., of a few frames) are frequently all that are needed for this test. They can be developed satisfactorily in a tray of the first developer for nine minutes with continuous agitation. The exposure standard and subsequent test strips should be made in the same way, of course.

In using these two materials as comparison standards or preliminary tests for Kodachrome pictures, it must be remembered that the paper will have an appreciably shorter latitude than Kodachrome film, whereas the black-and-white film will have a higher maximum density, more latitude, and higher photographic contrast (gamma). These differences can be considered, however, when the objective comparison standard is available. These characteristics of Direct Positive Panchromatic Film can be reduced by taking one-half the amount of potassium bromide for the first developer (Kodak D-67) recommended in the mimeographed sheet. Although this procedure degrades the usual pictorial quality of this film, the resultant pictures are more comparable with those of Kodachrome for the purpose.

The exact procedure for making an exposure standard is as follows:

Set up a test specimen. With a piece of Kodachrome film on the holder, make a series of time exposure steps with the draw slide, pushing it in for one inch after successive intervals of 1, 1, 2, 4, 8, etc., seconds (or intervals proportional thereto). At low powers or with an arc lamp, this may be 1/100, 1/100, 1/50, 1/50 + 1/25, 1/10, 1/10 + 1/5, 1/2, 1, etc., second. The result is a series of exposures, each twice the preceding one or equal to the next exposure time of the shutter. This film should be sent back for processing. A duplicate series of exposures should be made immediately, using the direct positive material. When the color film is returned, the two should be kept together as a standard.

When using Kodachrome Film, Type B, the Direct Positive Paper should be given the same exposure as is expected to be correct for the color film, since the speed of this paper to illumination from incandescent tungsten at 3200°K is approximately the same as that of Kodachrome, Type B. The Direct Positive Panchromatic Film should be given about 1/15 of the exposure given to the Kodachrome Film, Type A. An alternative technic is to set aside a neutral filter, such as the Wratten No. 96 Neutral Tint Filter of 1.0 density, and to use it whenever the black-and-white test film is exposed. In any case, because of some difference in latitude and contrast between the black-and-white film and the Kodachrome and also because of some differences in speed with individual processing, the exact relationship between the two films should be determined by comparison with the exposure standard. For these films, this should consist of strips of the color film and their black-and-white comparison strips mounted in parallel behind two slots in white cardboard.

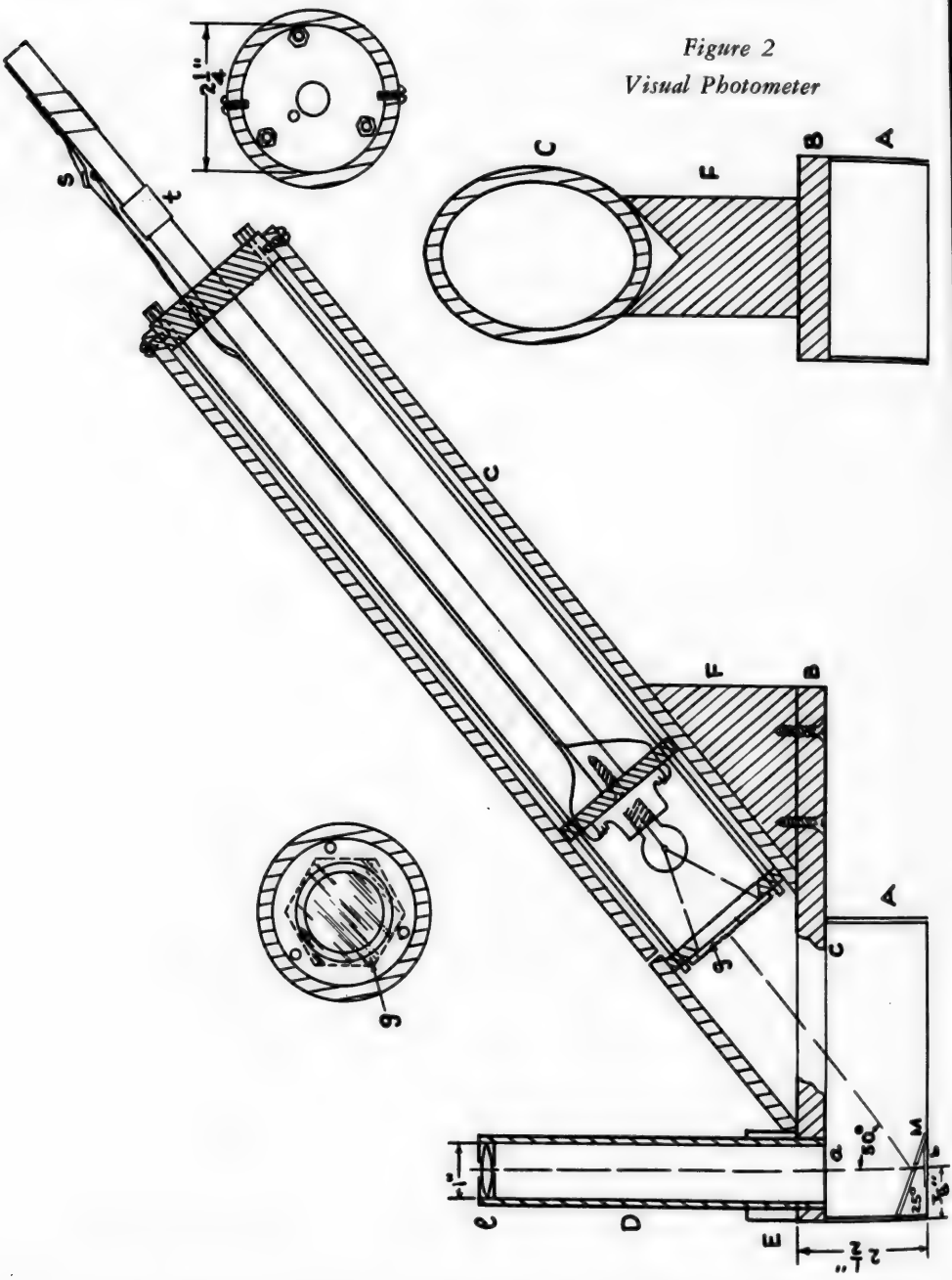
The *basic* standard for transparent illumination should be a test specimen, such as a thin cross section with an appreciable area of clear background present. Other standards can be made for cases where the contrast range is very great or where the detail of interest lies in a dense portion of the field.

APPENDIX

There are many different types of photometers and just which type is the most practical or the easiest to construct in any particular situation will vary. It may well depend upon the availability of some part, e.g., a photometer head, pair of Pola-screens, etc. The photometer described below (see figure 2) was devised principally because it is particularly simple optically, yet it is practical and has a small field of measurement and a relatively great brightness range which allows it to be easily calibrated with the usual hand exposure-meter. Although it is expedient in design to the point of crudeness, if found permanently useful, it can be perfected or elaborated in obvious ways.

1. The split-beam viewing chamber, A, was made from a strong cardboard box with a deep cover. A one-pound candy box was used for the instrument

Figure 2
Visual Photometer



described, although it is a little longer than necessary. The specification for the minimum height of the box is determined by the requirement of sufficient lateral clearance between the original and reflected light axes to allow the cylinder, C, carrying the lamp to clear the viewing tube, D. A sharp cork borer was found

to be the best instrument for making the round holes in the cardboard, with the box lying on a piece of wood. Holes a and b are directly in line and about 3/8 inch in diameter; a is on the top of the cover, and acts as a protector diaphragm. Hole b is eventually covered with a piece of flashed opal glass, diffusing side down, but it is wise to make a preliminary adjustment of the mirror, M first.

The beam-splitter is essentially the same as that devised by Capstaff and Purdy[6]. A thin rectangular piece of mirror should be procured, e.g., the kind found in the ten cent stores; the usual laboratory plate glass mirror is considerably too thick. A central aperture, 1/8 inch in diameter, clear of reflecting silver is made by scratching the backing including the silver, away with a needle. A very clean hole with sharp edges that are not undercut must be made but this can be done by covering the area with a thin metal template having a clean hole of the desired size. Two wedges of about 1/4 inch wood should be made with an angle of 25 degrees and cemented to the mirror so that the latter is supported at this angle with the silvered side down. The angle of the mirror is quite a critical matter in correlation with the other dimensions of the instrument since the slope of the inclined axis is exactly twice this angle, when measured from the vertical, and any deviation in the angle of the mirror changes the inclination of the inclined tube by double the amount. The aperture in the mirror must be in line with the two holes below and above it, and the plane of the mirror must be perpendicular to the sides of the box. When this is accomplished and its position marked, both the opal glass and the mirror are cemented in place.

A wooden board, preferably of plywood to avoid warping, 1/2 inch thick, as wide as the box cover, and about 9 1/2 inches long, is procured. The top of the box cover is to be glued and screwed to this but it is wise to make tentative assembly tests first. The center of the hole in the box cover and the wooden board, to accommodate the inclined axis, is best found by covering the top of the open box bottom with a diffusing paper and directing a light down the vertical axis. The dark spot of the mirror aperture should be evident to show the locating of this axis. If it is properly placed, put on the box cover. The paper will stick in the latter when it is removed, and a push pin can be thrust through to mark the spot in the top of the box. About a 2-inch hole in the box top and board is necessary for optical clearance.

A viewing tube, D, and a lens, 1, are necessary. A simple spectacle type of lens of 4—7 diopters and an inch or less in diameter is taped to the top of a stiff tube about 1 inch in diameter. A black paper disk with a central hole about 1/16 inch in diameter is placed below the lens and a protective black cardboard disk with a somewhat larger hole is placed above it. This whole unit, supported by the edge of the tube, is taped to its end. The tube is cut of such length as to bring the aperture in the mirror, M, into focus, i.e., a distance equal to the focal length of the lens. The tube fits snugly into a hole bored in the board but can be withdrawn at any time. An extra piece of wood, E, glued to the board, B, can be used to give more support and to allow some focusing of the lens.

A cardboard mailing tube with 1/4 inch walls and 2 1/4 inches internal diameter was found to be very good for the illumination tube. This unit can be made up separately and mounted on the split-beam viewing chamber. The tube cuts well with a sharp saw. A 50 degree bias cut is needed at one end. A length of 16 inches was found satisfactory to allow variation in brightness with the lamp by considerably more than a factor of 10, which is important.

A flashlight lamp can be used. A lamp originally designed for an aerial navigation instrument but now generally available as GE Mazda No. 412, 1.8-volt 0.73-ampere G 4 1/2 bulb is ideal for this purpose and worth some trouble to procure. The lamp in a miniature base is held on a wooden disk that must have sufficient clearance not only to slide easily along the tube but also not to mar a matte black finish that the interior of the tube must have. Therefore, an assembly is made consisting of a wooden disk at each end, each of which carries the ends of three metal rods placed symmetrically at 60 degrees and close to the edges of the two end disks. Curtain rods could be used for these. Hardwood dowel rods

[6] "A Compact Densitometer," Trans. *Soc. Mot. Pict. Eng. 31*, 1927, p. 607.

might be satisfactory if properly lubricated. The most convenient method of fastening the rods in the disks is with nuts, which requires that the ends be threaded. They can be held by any cement that holds metal to wood. In the figure, the third metal rod has been omitted to avoid confusion.

The central wooden disk bearing the lamp base must also have three holes placed to fit on the rods but of such diameter as to slip easily instead of fitting snugly, as with the other two pieces. Before fastening on the miniature lamp base, this disk should be fastened to the end of a hardwood dowel about 3/8 inch in diameter by means of a countersunk screw. The central hole in the upper end disk should pass this easily but not loosely.

Lamp cord is suitable for the wiring. The rubber-covered type slips in and out of the tube easily through the hole provided in the upper disk. The wire should be fastened to the outer end of the rod by tape. A push switch, s, should be provided in one of the wires and should be fastened to the central dowel rod, where it will be naturally held. A microswitch that was available proved to be ideal.

A piece of tape, t, wound around the dowel rod at the proper point acts as a stop to prevent insertion of the rod so far that the lamp bulb would be smashed against the diffusing opal glass, M. The lamp should be allowed to come very near to the diffusing glass, g, to gain high brightness.

The whole illumination assembly is pushed into the tube from the upper end and held in place by two screws in the upper disk. If the mailing tube is very slightly conical, as it was in this case, this fact should be ascertained before the tube is cut, in order to make the larger end the top with the squarely cut ends.

The position and direction of the tube should be carefully aligned before fastening it to the board. This is easily done with the illumination assembly out by holding a flashlight at the upper end of the tube and looking down the viewing tube, D. The tube is supported by a wood piece, F, the top edge of which has an inclination of 50 degrees. Looking from the end of piece, F, the inclined top has a V cross section of 45 degree angle. The piece is made from a single one-inch thick piece of wood with a 45 degree bevel at one edge and so cut as to make mirror images of the triangular pieces which are then glued together.

The tube, C, is held down to the board by a screw through the bottom of the lip, or by means of straps with the ends screwed into the wood. The metal strap used is not shown in the figure, but it held the tube very firmly. Any light-leak at the junction of the tube and the board is easily remedied by caulking with plastic wood. The whole of the inside of the instrument should be made a dull black by painting with Kodak Dull Black Brushing Lacquer (No. 4) or its equivalent; it is very satisfactory to paint the outside of the instrument with the same material.

A slot should be cut in the tube for the insertion of neutral densities in front of the diffusing aperture. Strips of film from a Wratten No. 96 Gelatin Filter, having densities 1.0 and 2.0, respectively, should be procured for this. If the slot brings the rectangular strip of filter film close to the aperture and the latter is adequately covered, the nominal transmissions of 1/10th and 1/100th can be used with validity. In any case, they can be calibrated since the brightness range obtained by withdrawing the tube is greater than 1:10. By means of these densities, the instrument can be calibrated at high values of illumination, but used for much lower values than can be measured with the barrier-layer type of photocells.

A fairly long lamp cord will probably be needed for the photometer unless the batteries are carried with it, which is inconvenient. The voltage drop in the cord, which is a constant, can be overcome by supplying additional battery voltage with a variable resistance, but in this case, a D. C. ammeter must be available that measures the 1.0-2.0 ampere range with reasonable accuracy. If no ammeter is available, the photometer must be checked against a standard illumination or with the aid of a photocell before and after nearly every measurement.

Assuming that an ammeter is at hand, the power unit is most conveniently assembled in a box, such as a fiber box. For the Mazda No. 412 bulb, two standard-size 1.5-volt dry batteries will be wanted. A variable rheostat of 2 or 3 ohms can be obtained from radio stores for less than one dollar. The rheostat

is best mounted on the side of the box and the ammeter included in it also. The lamp should be burned slightly below its rated voltage to prolong its life and preferably seasoned by burning for some time with a much reduced current. When maintained below its rated amperage by only a few tenths of an ampere, a seasoned lamp can usually be counted on to produce the same illumination with the same current for some hours, which enormously reduces the recalibration requirements. The switch, s, should be depressed for sufficient time before reading to allow the battery to come to equilibrium.

For recalibration, a sheet of glass is transilluminated uniformly by any source of light having the approximate color temperature of interest. The illumination in this plane is varied, usually by merely changing its distance from the lamp. It is convenient to vary it until an integral unit value of illumination is obtained *as read by a photoelectric exposure meter* which is accepted as the standard. This is then read also by the visual instrument and a mark made directly on the dowel rod as it emerges from the tube, or preferably the distance from the zero point of the scale measured along the rod. A succession of such measurements are made. The distance from the diffusing glass to the lamp filament at the minimum scale distance should be determined and this constant added to the various scale distances on the dowel rod to give values of $(c'_0 + d_1)$, $(d_0 + d_2)$, etc. A graph in which the illumination is plotted against the lamp distance from the diffusing glass should be drawn. If the illumination is graphed against $\frac{1}{(d_0 + d)^2}$ using Table II or Codex Log-Log paper No. 4123, the graph will be linear over some of the range. It will not be linear with the lamp closer than about 1¾ inches. The $I - \frac{1}{(d_0 + d)^2}$ graph intersects the illumination axis slightly above the origin because of the fraction of the beam that is internally reflected at such distances in this undiaphragmed small tube. Considerable improvement would be achieved in this respect by inserting a series of thin but stiff black diaphragms on the rods between the lamp and the diffusing glass. They should have apertures no larger than the end aperture at the maximum. They could be pushed in by the lamp socket until they collapsed together or be pulled into position by connecting threads. However, this extra preparation, although worth while, has not been specified since the instrument can be used as a calibration device. It is preferable to mark the dowel finally from a calibration curve rather than directly during calibration measurements. When a new lamp is used or a new calibration is needed, adjustment of the rheostat to correct for one point on the scale should be sufficient.

2. The chief disadvantage of this instrument is the size of the area of the bottom of the viewing box, although the field itself is small. Where this is serious because of mechanical obstructions in the plane of the image, another type of photometer can be made. A much smaller split-beam viewing chamber results from the following construction: The mirror, M, is inclined at 45 degrees and another mirror is placed directly opposite it, also inclined at 45 degrees (with an included angle of 90 degrees between mirrors). The light beam is thus reflected back vertically (measuring from the viewing tube) through a small hole in the top cover and board. Over this, a third mirror reflects the light axis again horizontally along the board. The height of this axis from the board is completely adjustable by the position of this last mirror. The lamp lies on this horizontal axis. Its illumination can be varied by any desirable means, including variation of its distance. Usually, the best position for the comparison diffusing surface with this arrangement is at the top of the viewing chamber below the board. A very satisfactory photometer of this type was made using a variable diaphragm* directly in front of an f. 2 condenser lens which imaged the lamp filament on another diffusing glass *on top of the board*. The lower glass was always evenly illuminated. The chamber between the two pieces of flashed opal glass must be painted white. Any such system is less efficient optically than the one described but this defect can be overcome by the use of a 15 C. P. automobile headlight lamp run from a storage battery. The scale in this case is an angular one made by an extension of the diaphragm lever moving against white cardboard.

* Iris Diaphragm No. 8 with Screw Flange Adapter, $6.00, Bausch and Lomb Optical Company.

Photography of White Objects

F. R. Harding*

THE main problem involved in the photographing of white material is one of proper lighting. Extra care is also necessary in processing, particularly in development.

Lighting requires much care and thought in bringing out the surface texture of a white subject. Most objects photographed in the medical field have contrast of color and may be photographed by flat light and still show surface form. Flat light might not be the best lighting for the subject, but a usable protograph will result. If flat light is attempted with a white object, nothing but its outline form will register because of the lack of contrast in the subject. Therefore, as a white object has no contrast in flat light, it becomes necessary to use lateral or side lighting in order to register the surface texture of the subject. The position of the light source in relation to the subject will be in large measure the governing factor of success or failure. Many positions of side lighting must be tried if the best possible result is to be obtained. An assistant may pass the light slowly around the subject, at different levels, while the focussing screen of the camera is being observed. Very possibly more than one position of the light will produce satisfactory results. It must be understood that there are several different degrees of side lighting, and quite often the maximum amount will not be the best.

The type of lamp used for illumination will also have some bearing on the end result. Some subjects will register best with a diffuse or soft light source, such as a photoflood lamp, which has a frosted lamp shell. Other subjects will show best if a spotlight is used. A spotlight will create the greatest contrast and will require careful use of a reflector if the subject has height or a very irregular surface. A very good lamp for general white object photography is the 500 watt or 1000 watt clear T20. This lamp produces strong shadows without quite the "wire sharp" shadow definition shown by the spotlight. In the order of sharp shadow lines the lamps would rate, first, the spotlight, second, clear T20, third, the photoflood. By combining the T20 lamp with a sheet of opal glass it is possible to have soft shadow edges similar to those produced by the photoflood lamp.

* From Children's Hospital, Boston, Mass. Presented at the Fourteenth Annual Convention of the Biological Photographic Association, September 8, 1944, at Binghamton, N. Y. Received for publication October 10, 1944.

Figure 1 Zinc oxide resulting from welding on galvanized material. Lighted by one 1000 watt T20 lamp diffused with opal glass.

The background for white objects should be smooth and black so that there will be maximum contrast between the subject and the background. If the background is not smooth there is danger of surface irregularity showing in the photograph.

The film employed must be capable of rendering a long scale of tones, and *must* be processed in a developer producing normal contrast. Avoid all films and developers that tend to build up contrast, because they will block up delicate highlight detail if sufficient exposure is given to register detail in the shadows.

The exposure must be calculated with great care, because if the film is overexposed all detail will be lost in the highlights. The use of an exposure meter will help greatly in exposure computation. Remember that the subject is white, and for that reason the exposure will be less than for a normal subject.

When lantern slides are made of white objects, better results will frequently be obtained if the slide is somewhat overexposed and fully developed. Reduce the slide in Farmers' Reducer, or take the slide

directly from the fixing bath, and without rinsing or draining, put it in a solution made up with 20 grains of postassium ferricyanide and 6 ounces of water until it has reduced to normal density. This method preserves the detail and sparkle of the highlights and makes a much more pleasing slide than those made by normal exposure and development.

Because of the different viewing mediums used in viewing slides and transparencies and prints, transmitted light and reflected light respectively, and the difference in tone scale of film, slide, and paper emulsions, prints of white objects seldom if ever equal in detail and brilliance a transparency or lantern slide made from the same negative.

A reflector should always be used if there is surface irregularity on the shadow side of the object, otherwise there will be poor balance between highlight and shadow, the shadows appearing so dark that little or no detail is visible.

Summing up, the factors governing good white object photography are, a thorough understanding of the proper use of light, great care in processing, and cleanliness throughout the cycle of operations from placing the object on the background to spotting the print or lantern slide.

The supply of back copies of the JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION is dwindling rapidly. Most desperately needed are: September 1944, 1943, 1942, 1941, 1940 and December 1943, 1939.

If any subscriber has copies that are not being used or bound for reference he is requested to send them to the Publication Office, Journal of the Biological Photographic Association, 561 North 15th Street, Milwaukee 3, Wisconsin, for distribution to those making request for them.

Especially qualified to work with children and in the natural sciences, using motion picture or still photography, a professional photographer and member of the BPA is interested in collaborating with research scientists.

For further details please correspond with

MISS ROSE ELIASBERG, 420 West End Avenue
New York 24, N.Y.

Color From the Photo-Engraver's View Point

by Addis W. Dempsey*

THIS discussion of color from the photo-engraver's view point is presented from the practical standpoint rather than the technical one.

Photo-engravers receive a wide variety of color copy for reproduction—paintings, color drawings, color photographs, transparencies and prints, black-and-white photographs, drawings with color sketches indicating how the color shall be placed and monochrome subjects with or without a description of how the finished color plates should appear.

The sizes and resultant scales of reduction or enlargement vary considerably. As in most copying it is better to reduce than to enlarge. A reduction of between one-half and one-third is preferable whether the original subject is a drawing or photograph. Of course, many times the scale of reduction may be 4, 6, 8 or 10 times. It is sometimes advantageous to the artist or photographer to work in these larger sizes particularly if the reproduction is to be quite small. Remember, however, fine detail of a large original is lost to the eye when reduced greatly. Then, too, in addition to the great reduction the halftone screen cuts up detail that is too fine for the particular fineness of screen.

There is less enlarging from 35 mm. color transparencies and other small ones than there was a few years ago for it is far more practical to start with a color transparency nearly as large or larger than the required finished plate size. Bear in mind that the separation halftone negatives printed on metal give the photo-engraver color finisher only an approximate rendering of the subject. They require considerable handwork correcting the values of each of the color plates to reproduce with fidelity the original subject. In so doing, the color finisher works with the original copy or photograph directly before him and refers to it constantly.

You can appreciate that referring to a 35 mm. color transparency as an accurate guide for making a set of plates 3, 5 or 10 times as large constitutes quite a chore. Sure, that is done frequently but it still does not constitute good working copy.

* Donovan and Sullivan Engraving Company, Boston, Mass. Presented at the 14th Annual Convention of the Biological Photographic Association. Binghamton, N. Y., September 8, 1944. Received for publication October 19, 1944.

In the making of halftone or color process photo-engravings the subject is photographed through a halftone screen to break up the subject from continuous tone into dots of varying sizes according to the tone values. There are three commonly used fine screens—120 which gives 14,400 dots to the square inch; 133 screen which gives 17,689 dots to the square inch and 150 screen which gives 22,500 dots to the square inch. Because the dots vary in size, are of the same number to the square inch all over the plates and are too fine to be individually noticeable to the eye a tonal effect is rendered. The finer the screen, however, the finer the detail which may be held by the screen.

Large copying cameras are used by photo-engravers. A circular screen of the desired fineness of ruling is placed in the camera in front of the ground glass. A prism is fixed on the lens to reverse the image so that stripping will be avoided. An image of the specified size is brought into sharp focus and then the camera is locked in position.

The screen is adjusted for its distance from the negative. Four separation halftone negatives are made each approximately representing the values of the particular color for which it is made.

The screen is turned 30 degrees in its frame before making each negative except for the yellow when it is turned 15 degrees so that the angle of screen is different for each color to avoid screen moire or pattern. These negatives then have the subject represented by black dots and clear negative. They are then printed on metal and after development the resultant image is burned in forming an acid resist. The result is a series of dots of acid resistant enamel and bare metal between dots. Now these prints represent only an approximation of the respective values of their colors.

The color finisher with the original copy before him and with constant reference to it etches the plates stopping the etching action in areas by painting out with acid resistant as those areas reach their proper values. Then for closer correction of values the plates are etched locally by application by the color finisher of compartively weak acid to the desired areas with a brush and the wiping away again in a matter of seconds. This is repeated many times until the size of the halftone dot is such that it will carry the proper amount of ink of its color for that particular area. These areas, of course, vary according to the subject. They may be one-sixteenth of an inch in diameter or very much larger.

In addition, sometimes it is necessary to tool areas in certain colors to cut their values down. It is sometimes necessary to remove completely the printing surface from some sections in one or two of the color plates. These steps require many hours of handwork dependent upon the subject and the plate size.

If there are several subjects of the same scale of reduction and of somewhat the same photographic values or, in case of color transparencies, of the same degree of density they may be reproduced together with a considerable saving of cost provided they can be illuminated properly and do not make too large a plate. You will note that it is particularly necessary in the case of transparencies to have the same degree of density.

Of course there are many tricks that can be performed to reproduce what otherwise might be poor copy. For instance, to go to an extreme, there have been cases where it has been advisable to work from a black-and-white copy, faking the color and using a color copy only as a guide for the finisher. It is far better, however, to prepare the copy properly at the start to be sure of what your finished results will be.

The question frequently comes up as to what type original is preferred for reproduction—a transparency or a color print. A good color print is preferable for many reasons but particularly because it can be illuminated by the same general illumination that the process halftone plates are when the color finisher is working on them. Another advantage of a color print is that it can be retouched readily and accurately so that the engraver has a correst copy and guide. When comparing proofs with the subject they both can be laid side by side under the same light and at the same eye level.

The appearance and color of transparencies varies greatly with the type and quality of light passed through them. At the same time on the same day, a transparency varies in appearance according to the light through which it is viewed whether it be Eastern sky, Northern sky, Western sky or any one of numerous artificial lights.

A short while ago we had a transparency to reproduce in which the color of a fabric was very important. The transparency was our accurate guide and working copy. When the proofs were compared with the actual fabric the reproduction was considerably warmer than it should have been. The trouble was finally traced to a faulty lamp in the transparency viewer which our color finisher happened to be using while working on that job. The match to the transparency viewed in that light was excellent. This example, while not typical, does illustrate one of the problems of reproduction with transparencies.

In preparing material for the photo-engraver the photographer should keep out of his photographs, colors and details which he does not want to appear in the finished printed results. Give the engraver copy which is accurate to what the finished results should be. Do not leave a lot of correction of detail and color to him unless there is no

other way of obtaining the results desired. Don't adopt the "Let George do it" attitude. It is liable to give very unsatisfactory results.

Get clean, crisp color whenever possible, bearing in mind that it will soften in reproduction. It is well to work in a broad way so far as lighting is concerned; that is, get your full range of values but do it in a mass way. Light, whenever possible, with broad areas of value which give illusion of contrast rather than minute ones which will be liable to disappear or flatten in the finished reproduction. In other words strive for brilliance rather than contrast.

Give the engraver a break by providing him with copy close to or larger than the desired plate size. Color deficiencies in the original can be corrected by the photo-engraver provided that the color deficiency can be described clearly enough to him and he is given a color sample. He doesn't know what color flesh should be under its various pathological conditions.

If an almost perfect color transparency or print is given to the engraver with sufficient time to do the job properly the original may be reproduced with only very slight loss in color fidelity. This is based on the assumption that a fair price is allowed the engraver so he doesn't have to cut corners to break even.

It is very important to give the engraver explicit instructions as to the important parts of illustrations particularly if any colors in a pathological area must be reproduced very accurately. When exact reproduction is necessary, as it would seem it should be frequently in biologic photography, it means more accurate and detailed finishing and probably several proofings. This, of course, runs into more working time and therefore more cost than an ordinary set of color process plates. Proofing alone runs up the cost of this type of work. A correction requiring only a few minutes work on the plates will require several or sometimes many hours of proofing time.

Occasionally it is necessary to add a fifth color. This is quite unusual and the need would be determined only by a particular subject.

If a set of process plates is to be used with a set that has already been made or if there are several sets to be printed together the inks used for all must be the same. There are many process blues ranging from the cold to the warm. The same is true of reds and yellows. When several sets of plates are to be made consult your engraver and let him select the yellow, red, blue and black which will best reproduce the subjects. Our national publications with all their color advertising and illustrations are printed with the same four color inks though the plates are made by many different engravers scattered through the country. All of the various engravers making plates for use in these magazines

are required to proof the plates with inks and on paper supplied by the publication. This should be adhered to in all color reproduction.

Process plates should be made to print with selected inks and proofed with those inks on the paper on which the job is to be printed. The paper part has more importance than it is ordinarily given for white coated papers vary considerably in their degree of white and color which, of course, effects the finished printed result. A change of either inks or paper after plates have been made is dangerous and sometimes disastrous, even though the actual press work may be excellent.

The printing of color process plates requires much more careful handling than even first-class printing of first-class black halftones. Register, of course, is important. The plates must be made ready and the ink distributed so that the proof of each color plate in its respective ink matches that corresponding proof in the engraver's set of progressive proofs. The selection of a good printer who knows color process printing and how to do it is of utmost importance. Savings of paper costs and printing costs are generally not very great in runs of a few thousand. The loss in reproduction quality is frequently far greater.

If letters or numerals are required to key certain sections of color plates to the reading matter they may be added by the engraver in black or one of the colors or white. Just give the engraver a layout or print indicating the exact position for each piece of type so that he may print them in before etching the plate.

To the layman it seems that many scientific illustrations appear to be too small to do their intended job and many scientific papers could carry more illustrations to good advantage. Color should play an important part in them. You see the use in general magazines and newspapers of color illustrations of editorial articles to help get points across and retain reader interest. For example Ladies' Home Journal increased from 377 editorial pages of color in 1939 to 494 in color in 1943—an increase of over 25%. Saturday Evening Post increased from 332 pages in 1939 to 1854 pages in 1943—an increase of over 500%. Bear in mind these were illustrations of articles and stories only. They are used to give the reader a better picture and understanding of what the written article is about than mere type or even black-and-white illustrations will do. In the medical and scientific world could not the same thing be applied to advantage?

To reiterate, put in photographs only what you want to get out of them. Select a qualified color engraver (one who has a reputation to maintain for quality reproduction in color). Consult him when doubts arise. Work with him thus making it a great deal easier mutually.

Ferdinand R. Harding, re-elected President of the Biological Photographic Association in 1944, is head of the Photographic Department of the Children's Hospital in Boston, Massachusetts, and does general clinical, surgical, motion picture and gross pathological photography. Mr. Harding took his present position in 1929, having reached it via commercial photography. Since his clinical subjects are children he has wide experience in the graphic recording of growth changes and has contributed several original technics to this field. If he had not gone into medical photography, and had not heard of and joined the BPA, we would be minus one President, one Director of long standing, and our most consistent contributor to the Journal.

News From the Trade

F. R. Harding*

ANSCO COLOR SHEET FILM AND DEVELOPING OUTFITS RELEASED THROUGHOUT THE UNITED STATES

Ansco's new Color Film, designed for processing by the user, is being released to amateur and professional photographers throughout the country for the first time since it was put in production for the exclusive use of the armed forces and war industries.

Company officials at the same time announced that special Developing Outfits for individual processing of the film also are being placed on the market.

Only film in sheet sizes will be available for the present.

No priority is needed to obtain Ansco Color Film now although the military and essential industries will continue to have first call on the volume being produced.

For those who do not wish to do their own processing, such service is available through Ansco dealers. Special facilities have been installed in the Ansco Color Laboratory to maintain rapid service to the dealers.

NEW LEICA PRODUCTS

We learn from an announcement by E. Leitz, Inc. that LEICA American Craftsmen have "chalked up" further achievements. They will soon have available a new 127 mm f.4.5 lens for the Leica camera. All American made, including optics and the specialized helical focusing mount which couples directly with the built-in range finder of the Leica Camera.

This new lens is for use in getting close-ups of distant objects—it produces images more than twice the size of those made with a standard 50mm Leica lens, and will also produce portraits with much better perspective. The lens is highly corrected and makes very sharp pictures.

Another new Leica product to be released shortly is an Image-Erecting Universal View Finder.

KODAK ANNOUNCES SUPER PANCHRO-PRESS—SPORTS TYPE

The fastest film ever made available is announced by the Eastman Kodak Company for the news photographer, who must, at times, work

* From Children's Hospital, Boston, Mass. Received for publication October 18, 1944.

under extremely adverse light conditions, or for other work which must be made at fast shutter speeds with illumination that would be inadequate with the ordinary fast film.

This film known as "Super Panchro-Press—Sports Type" is a modification of "Super Panchro-Press, Type B" which will still be supplied for all general work.

When developed as recommended, "Super Panchro-Press—Sport Type," is about twice as fast as the "Type B." As a result of the great increase in speed there is a slight increase in graininess and a slower rate of development.

For many sports pictures where ordinary high speed film is employed, it is necessary under adverse light conditions to use the lens at its widest aperture to compensate for the poor light and to gain maximum exposure with the high shutter speed that is required to stop the fast action.

NEWS FROM DEFENDER PHOTO SUPPLY COMPANY

The Defender Photo Supply Company is now supplying a full range of gelatin filters both regular and lacquered. The lacquered filters can be handled and cleaned. For further information direct inquiries to Defender Photo Supply Company, Inc., Rochester 3, New York.

Book Review

THE YEAR'S PHOTOGRAPHY 1944-1945. A Royal Society Publication, London, England.

This year's publication is somewhat smaller than in past years, in text, illustrations and advertising pages, due no doubt to the same paper shortage that exists in this country.

However the pictures are excellent — running a little heavy toward portraits, easily explained by the wartime restrictions on photographing outdoor scenes and subjects.

It was thrilling to see our General Eisenhower as the subject for the first illustration, an excellent portrait by I. A. C. Redhead, F.R.P.S.

Various nature shots and still life subjects are of the highest standard.

Salon exhibitors from the U. S. A. were well represented.

The publishers are to be commended for surmounting the many difficulties that exist in issuing this excellent coverage of "The Year's Photography."

RAY MIESS

Association News

PROGRAM
FOURTEENTH ANNUAL CONVENTION
OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION, INC.
September 7, 8, 9, 1944, Arlington Hotel, Binghamton, N.Y.

CONVENTION CHAIRMAN
Lloyd E. Varden, Education Department, Ansco, Binghamton, N.Y.

THURSDAY, SEPTEMBER 7, 1944

9:00-10:00 A.M.—Registration and Opening Session.

10:00 A.M.—"Calibration of a Photomicrographic Equipment"
John A. Maurer, DeVry Corporation, Chicago, Ill.

10:30 A.M.—"A Report on Light Sources for Photographic Purposes"
Frank E. Carlson, General Electric Company, Cleveland, Ohio.

11:00 A.M.—"Medical Illustration Progress in the U. S. Army"
Captain Ralph Creer, Army Medical Museum, Washington, D.C.

11:30 A.M.—Business Meeting
Recess for Lunch

2:00 P.M.—"Optical Staining"
George L. Royer, Calco Chemical Division, American Cyanamid Co., Bound Brook, N.J.

3:00 P.M.—"Postwar Visual Education in Medicine"
Thomas Jones, Colleges of Medicine, Dentistry and Pharmacy, University of Illinois, Chicago, Ill.

3:30 P.M.—Ansco Color Film Processing Demonstration
Lloyd E. Varden, Ansco, Binghamton, N.Y.

4:30 P.M.—"Motion Pictures Through the Proctoscope"
Dr. Jay M. Garner, Winnetka, Ill.

8:00 P.M.—Round Table

FRIDAY, SEPTEMBER 8, 1944

9:30 A.M.—"A New Method for Intensifying the Latent Image"
Dr. F. W. H. Mueller and J. E. Bates, Ansco, Binghamton, N.Y.

10:00 A.M.—"Medicine in Action.
Lt. Wilbour C. Lown, U.S.N.R., Motion Picture Division, U.S. Naval Hospital, Bethesda, Md.

10:30 A.M.—"Color from the Photo-Engraver's Standpoint"
Addis Dempsey, Donovan & Sullivan Engraving Co., Boston, Mass.

11:00 A.M.—"Modern Technics in the Preparation of Visual Aids"
Dr. Bruce Buckler, Visual Education Dept., International Business Machines Corp., Endicott, N.Y.

11:45 A.M.—Election of Officers

Recess for Lunch

1:30 P.M.—Ansco Plant Trip

4:00 P.M.—Ansco Cocktail Party and Clambake

SATURDAY, SEPTEMBER 9, 1944

9:30 A.M.—"Photographic Technic in the Operating Room"
Howard R. Trissel, Adel Precision Products Corp., Burbank, Cal.

10:00 A.M.—"Photographing Live Fish in Tanks"
H. Lou Gibson, Eastman Kodak Co., Rochester, N.Y.

11:00 A.M.—"Experiences with Photography in Aviation-Medicine"
Lardner A. Coffey, Mayo Clinic, Rochester, Minn.

11:30 A.M.—"Photography of White Objects"
Ferdinand Harding, Children's Hospital, Boston, Mass.

The following firms had displays in the Technical Exhibit:

Adel Precision Products Corp., Burbank, Cal.
Ansco, Binghamton, N.Y.
Bacon & Vincent Co., Buffalo, N.Y.
Clay-Adams Co., New York 10, N.Y.
Defender Photo Supply Co., Inc., New York 1, N.Y.
Eastman Kodak Co., Rochester 4, N.Y.
Gamma Instrument Co., Inc., New York 16, N.Y.
Ilex Optical Co., Rochester, N.Y.
Polaroid Corp., Cambridge 39, Mass.
Spencer Lens Co., Buffalo 11, N.Y.

NEW WORK BY OUR MEMBERS

Mr. Julin and Mr. McComb have supplied the photographs for the book "Traumatic Injuries of Facial Bones". The authors are Dr. John B. Erich, M.S., D.D.S., M.D., and Louie T. Austin, D.D.S., F.A.C.D., of the Mayo Clinic The book was written in collaboration with the Bureau of Medicine and Surgery, U.S. Navy. In a foreword by Ross T. McIntire, Rear Admiral, M.C., U.S.N., The Surgeon General of the Navy, he includes the following statement: "I am particularly impressed with the manner in which the subject matter is presented, and I think that one of the finest things is the way in which the book is illustrated."

Mr. McComb's work consisted of 5 x 7 inch photographs. Mr. Julin made a 1200 foot motion picture for teaching purposes. From this Kodachrome film he made enlarged black and white negatives. The 16mm frames were enlarged to a width of four inches and contact prints were reproduced this size in the book. Several color plates were made two inches wide from the 16mm film. More than 300 illustrations appear in the book and about one-third of them are from movie film. The frontispiece is from a 5 x 7 Kodachrome made by Mr. McComb. (Publishers: W. B. Saunders Company, Philadelphia, Pa., 1944).

A new type of microscopy making use of "Phase difference" was demonstrated by the Spencer Lens Co. at the Cleveland Meeting of the A.A.A.S. The specimen under the microscope is illuminated with a hollow cone of light and a phase plate is placed within the objective. Depending on the kind of phase plate any regions within the specimen of different refractive index may be made bright on a dark background or dark on a light background. The invisible phase differences are converted into intensity differences to which the eye is sensitive. According to the statement issued by the company, the new microscope equipment will permit observation of the structure and some of the functions of living cells and tissues. Mold and bacteria are made visible and may be counted. Details necessary for identification are revealed without recourse to staining or damage to them; and with considerable saving of time and materials. Specimens many times too large for the electron microscope may be studied. So far there is little promise that the electron microscope may be used with living material beyond perhaps the smallest specimens. Many problems require the study of larger organisms, such as cancerous growths, than now possible with the electron microscope.

The light and electron microscope complement each other; the phase difference method will greatly extend the usefulness of the light microscope. Phase difference photomicrographs of a grating were

made as early as 1905 in England. The Spencer contribution extends the method to the general case, the discovery that absorption may be as or more important than retardation, the preparation and use of a wide range of phase discs of both position and negative types, and improved methods for coating the thin films in the manufacture of the phase plates. This advance in microscopy was accomplished by the cooperation and pooling of knowledge and scientific and technical skills of physicists and research workers in the Spencer Lens Co. The testing and practical applications were made by our member and Director Dr. O. W. Richards, Biologist.

There are now available for teaching purposes six sets, each consisting of 86, 28 x 40mm slides, 35 in Kodachrome, and a condensed lecture brochure. These slides cover the subject of acute and chronic bacillary dysentery, including the newer aspects of the epidemiology, pathology, bacteriology, serology, clinical phases, prophylactic and curative therapy. They are available on loan to Army, Navy, public health and university teachers without cost except that of mailing. The project is part of a longe-range plan of the Dysentery Registry for the dissemination of our ever-growing knowledge of the important subjects of bacillary dysentery, enteritis and colitis. It was deemed expedient to stress the military aspects at this time. Requests will be honored in order of their receipt. The date on which the slides will be used should be specified. The total time of presentation is approximately 90 minutes at the ordinary talking speed. The slides are so arranged that they may be presented in a single lecture, two lectures of 45 minutes each, or three lectures of 30 minutes each.

Dr. Joseph Felsen, 120 East 39th Street, New York, has been working with the Dysentery Registry on the project of compiling loan teaching sets on Bacillary Dysentery.

ANNUAL MEETING

We had a record attendance at the Binghamton meeting, 120 registrations. The Association's heartiest thanks are due Ansco and our Convention Chairman, Lloyd Varden, for a stimulating meeting and for the pleasant evening at Ansco Lake. Many letters have come in from individual members expressing their appreciation of this outstanding meeting, and we know all who attended will heartily endorse the thanks which we wish to place on record here.

The business meeting was short. Miss Zimmer and Mr. Massopust read the Treasurer's and Editor's reports. The formal report of the Motion Picture Committee will be given in the Journal, but Dr. Richards spoke informally about the good work being done by the Society of

American Bacteriologists in reviewing and abstracting films. Mr. Smith reported that the questionnaires answered by incoming B.P.A. members had been analyzed to date and the information compiled on file cards. The Association is amassing some valuable data about the equipment, general interests, etc. of its members, and a study will be made of the possible uses of this information.

The Nominating Committee did not follow its usual procedure of reading the nominations at this session, as the resignation of Mr. Henry Morris, Vice President, from the Board had necessitated a revision in the ticket. A report was given however by the Chairman, Mr. Julian Carlile at the afternoon session. The nominations were:

President	Mr. Ferdinand Harding
Vice President	Mr. Stanley McComb
Secretary	Miss Anne Shiras
Treasurer	Miss Stella Zimmer
Director	Mr. Nathan Horton
Director	Mr. Louis P. Flory

The election of officers was held on Saturday morning, when nominations from the floor were invited. The members however, voted unanimously that the Secretary be authorized to cast one ballot for the Nominating Committee's entire ticket.

At the end of the Saturday morning sessions a rising vote of thanks was unanimously given to Ansco and to our Convention Chairman, Mr. Lloyd Varden.

Round Table, Thursday Evening, Sept. 7. At the informal evening session, the stands bearing Salon prints were placed one by one before the members, and the photographers who had prints on exhibit discussed the problems involved in their various pictures and the technics by which they were made. The largest single exhibit was from Mrs. L. Grabherr of Santiago, Chile. Dr. Richards, who had translated the captions kindly volunteered to speak on this exhibit and emphasized the B.P.A.'s good fortune in having as members photographers of high ability from other countries. Mr. John Maurer, now with Ansco, presided at the round-table.

SUSTAINING MEMBERS

Some individuals who have a deep interest in the advance of scientific photography help finance a wider range of activities for the Association by becoming Sustaining Members. The privileges of Regular and Sus-

taining members are the same. Either type may be chosen each July when the dues are payable.

Cammon, W. A. "Don", D.O.S.
Cameron Surgical Specialty Company
666 West Division Street
Chicago 10, Illinois

Davidson, Emil
Clay-Adams & Company
44 East 23rd Street
New York 10, N.Y.

Flory, Louis P.
Boyce Thompson Institute
for Plant Research
1086 Broadway
Yonkers 2, N.Y.

Garner, Jay M., M.D.
723 Elm Street
Winnetka, Ill.

Gibson, H. Lou
Eastman Kodak Company
343 State Street
Rochester 4, N.Y.

Hagaman, R. S.
Defender Photo Supply Co.
Rochester 3, N.Y.

Horton, Nathan S.
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1944 SALON REPORT

One thing about the 1944 Salon which was particularly outstanding was the splendid hanging facilities. Not only did we have ideal conditions for displaying the prints, but the exhibit room was all that could be desired by even the most critical. Our deep appreciation goes to the Ansco Corporation for the facilities provided for hanging prints and displaying transparencies.

For those who did not attend the convention, a brief description might be of interest.

The prints were arranged on beautifully designed boards having a surface covering of a natural shade of monk's cloth. These double-sided movable boards were perfectly illuminated by fluorescent lighting along the top. The transparencies were displayed in large, un.form-sized shadow boxes, also utilizing fluorescent lighting. The exhibition room was very large, which meant that the salon and the exhibitors' displays were pleasingly arranged without any crowding. It certainly is a pleasure to have such facilities for exhibition and Salon space.

For those who are statistically-minded, the following brief data are presented: The total number of prints hung was the pleasingly high figure of 183. Of this number however, 112 5x7 unmounted prints were hung as a unit. These were received from Chile and represented a very interesting cross-section of clinical photography. Actually, the total number of prints received exceeded the total figure mentioned above, but we were forced to adhere to a Salon ruling that prints arriving too late might be exhibited, but could not be considered as official entries. Eighteen excellent color prints were hung . . . the finest color work we have ever had.

The breakdown of the subject matter (other than the Chilean Exhibit) was as follows:

Photomicrographs	31
Gross Specimens	12
Ophthamology	7
Infra-Red	5
Miscellaneous Nature Studies	10
Miscellaneous Clinical Subjects	6

In the transparency section we had a total of 333 . . . all in color. This is an unsually good representation of transparencies. Included in these figures are the 132 transparencies shown in the Army Medical Museum Group.

NATHAN S. HORTON,
Salon Chairman,
New York, N. Y.

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FORESTRY

The Journal of the Biological Photographic Association

MAR 19 1945

MARCH

VOLUME XIII 1945 NUMBER 3

LEO C. MASSOPUST,
EDITOR

For the advancement of photography in relation to the biological sciences.

Published Quarterly For The
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At 561 North Fifteenth Street
Milwaukee 3, Wisconsin

OFFICIAL PUBLICATION OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

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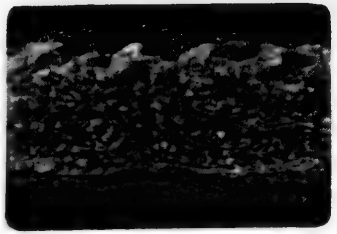

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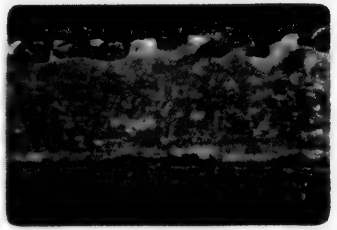

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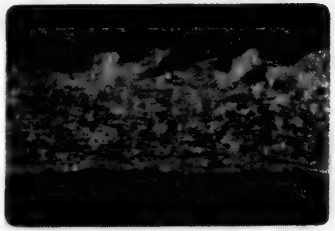

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"Optical Staining"

G. L. Royer, C. Maresh and A. M. Harding*

THE method of producing color contrasts by the use of filters in the microscope condenser was first described by J. Rheinberg[1] in 1896 and is described in several books on microscopy[2,3]. In this procedure, filters to cover various portions of the condenser aperture must be made and adjusted to fit the apertures of the objectives being used. To overcome this inconvenience, the Zeiss Company introduced the Mikropolychromar which was constructed so

---

Description of Color Plate

The photomicrographs reproduced on the color plate illustrate the use of optical staining technic. A detailed description of each figure follows:

Figure 1 A cross section of leather dyed with Calcomine Red 8BL. This picture was taken by the usual bright field method of microscopical illumination in which the specimen is shown by transmitted light. Because of the thickness of the section, it is not possible for light to come through the dyed portion and show it as the same color as would be obtained by reflected light. The magnification is 15×.

Figure 2 Same section shown in Figure 1 but photographed by the dark field method of microscopical illumination. The specimen is shown by reflected light only using the Mikropolychromar with the direct beam obstructed and illuminated only by the indirect beam which in this case was white light. The magnification is 15×.

Figure 3 Same section as shown in Figure 1 illuminated by the use of the Mikropolychromar using white indirect illumination and green direct illumination, The use of the green-colored direct illumination gives good contrast between the red dyed portion of the leather and the background. The magnification is 15×.

Figure 4 The same cross section as shown in Figure 1 illuminated by white indirect light and blue direct light. Again the blue color gives good color contrast between the red dyed portion of the specimen and the background. The magnification is 15×.

*Calco Chemical Division, American Cyanamid Company, Bound Brook, N.J. Presented at the Fourteenth Annual Convention of the Biological Photographic Association, Binghamton, N.Y., September 7, 1944. Received for publication September 23, 1944.

[1]J. Rheinberg, Royal Microscopical Society 1896, pp. 369, 373-388. 1899, pp. 142-146, 243-245.
Journal of the Quekett Microscopical Club, 1897, pp. 346 and 438.
Archiv. für Mikrosk. Anatomie, Vol. 50, 1897.
The Annual of Microscopy, 1898.

[2]Chamot, E. M. and Mason, C. W., Handbook of Chemical Microscopy, Vol. I Second ed., p. 92 (New York, 1938).

[3]Photomicrography, Eastman Kodak Company (Rochester, New York, 1935).

that the apertures and color filters could be changed and adapted to different conditions. Work by several authors[4,5,6,7,8,9] in Germany has described the use of the Mikropolychromar in different fields. In this paper, it is proposed to describe the apparatus briefly, the use in microscopical illumination and the method for taking photomicrographs in color.

Optical Principles

Objects under the microscope can be seen because of the following characteristic images produced by light: 1) absorption, 2) refraction, 3) reflection, and 4) diffraction. All of these in different proportions make up the final microscope image depending upon the type of illumination, the method of mounting and the subject. In the visual microscope, the absorption image produces the color. The refraction and reflection images arise where differences of refractive index exist. The diffraction image is formed when the fineness of structure approaches the size of the wave length of light and interference occurs as the light passes through the structure to form colors and often spurious images.

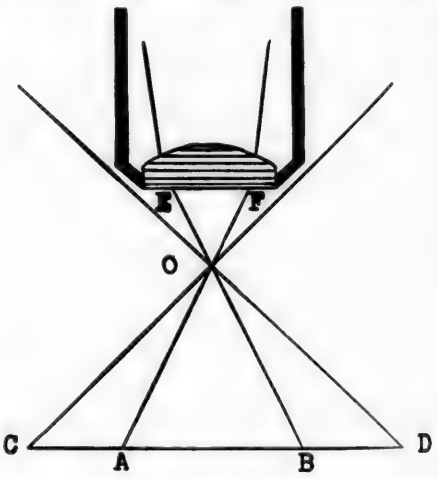

Figure 1

The appearance of any object under the microscope by transmitted light depends to a great extent upon how it is illuminated and for this reason the condenser of the microscope is a very important part, the correct manipulation of which is often overlooked. The object is usually viewed by bright field illumination in which case it is seen mostly

[4]E. Bunning, Zeitschrift für wissenschaftliche Mikroskopie und für Mikroskopische Technik, *52* (1935). Some Observations on the Flow of Granules in the Stamen Hairs of the Tradescantia, Including Notes on the Use of the Mikropolychromar in the Study of Cell Physiology.

[5]De Crinis, Kleinische Wochenschrift, Vol. 14, No. 27, pp. 961-962. A New Method for Rapid Histological Diagnosis as far as it is Significant in Brain Surgery.

[6]P. Kraft, Zeitschrift der Deutschen Geologischen Gesellschaft, *84*, No. 9, 651/2 (1932) (Extract from a lecture). Optical Staining of Microscopic Objects by Means of the Mikropolychromar.

[7]K. Richter and H. Damm, Die Naturivissenschaften, *27*, 517/18 (1933). The Use of the Mikropolychromar in the Determination of Microscopic Melting Points.

[8]H. Schnegg & K. Weigand, Zeitschrift für das gesamte Brauwesen, No. 13, 1935. The Mikropolychromar as Used in the Control of Biological Plant Operation (Communication from the Physiological Fermentation Institute Weihenstephan of the Technical High School of Munich).

[9]P. Schugt, Pharmazeutische Zeitung, Vol. 79, No. 18, 228-231 (1934). Chemical and Optical Staining of Urine Sediment; Preparation of Permanent Samples.

because of its absorption color and refraction image. This can also be called the direct image caused by the axial transmitted light from the condenser. In figure 1, this is the cone of illumination AOB from the condenser which can just be taken in by the aperture of the objective. EF. When the condenser aperture is opened further to give the cone COD in figure 1, the extra light can only get into the objective if it is reflected by the object so as to be within the aperture of the objective. This latter image is often called the indirect or reflected image. If the center cone AOB is blocked out by the insertion of a center

---

DESCRIPTION OF COLOR PLATE (continued)

Figure 5 The same cross section shown in Figure 1 but illuminated by the Mikropolychromar using white indirect illumination and red direct illumination. This is a very poor choice of color for the direct or background illumination in that the color contrast between the red-dyed leather and the background does not exist. In all five figures, the indirect illumination used was white light so that the natural color of the leather and the dyed portion of the section would be shown in their true color and stand out against a colored background. The magnification is 15×.

Figure 6 Potato starch grains photographed by the Mikropolychromar method of illumination using blue direct light and red indirect light. The red indirect light shows up at those portions where red light is reflected by the sample, the background being the color of the direct illumination. The magnification is 25×.

Figure 7 Sulfanilamide—This photomicrograph of a single crystal of sulfanilamide was taken with red direct illumination and blue indirect illumination. It shows the crystal edges in blue against a red background. The magnification is 25×.

Figure 8 Sulfanilamide—This is a photomicrograph of a single crystal of sulfanilamide taken with the Mikropolychromar using blue direct illumination and red indirect illumination. It shows the edges of the crystal to be red on a blue background. In these crystal pictures, this type of illumination makes the surface quite evident. In this way, pits, scratches and other irregularities on the surface of the crystals can be clearly seen in one color contrasted against another colored background. The magnification is 25×.

Figure 9 Sodium Sulfadiazine—Photomicrographs show a number of crystals of sulfadiazine photographed by the Mikropolychromar using blue direct and yellow indirect illumination. The magnification is 25×.

Figure 10 Some of the same crystals shown in Figure 9 using blue direct and red indirect illumination. The magnification is 25×.

Figure 11 Some of the same crystals shown in Figure 9 using red direct and green indirect illumination. The magnification is 25×.

Figure 12 Some of the same crystals shown in Figure 9 using red direct and blue indirect illumination. The magnification is 25×.

stop, this image only is seen and this type of illumination is called dark field.

APPARATUS

The Mikropolychromar is a condenser which is built so that the direct and indirect illumination can be independently controlled in both intensity and color. Figure 2, taken partly from the Zeiss literature, shows a schematic view and the explanation below the figure describes the various parts.

The use of this type of illumination requires a good understanding of the apertures of the condenser and their relation to the aperture of the microscope objective. It is necessary to have the condenser properly focused on the object. When the Köhler method of illumination is used, the diaphragm of the light source should be focused in the plane of the object on the slide. In this case, the aperture of the condenser should be filled with light before focusing the enlarged image of the source at this point. If this is not possible, a diffusing glass surface is introduced here so as to fill the entire condenser aperture. A special lamp designed by Zeiss for use with the Mikropolychromar may be used. In use at low powers, it has been found necessary to raise the object slide above the stage so that the low power condenser can be properly brought to focus. This is done with an elevator ring as shown in figure 2-16.

The center cone or axial aperture of the condenser must not be greater than the aperture of the objective, this controls the intensity and color of the field. The outer hollow cone or annular aperture should be such as to allow no light to go directly into the objective, this controls the light deflected by the object into the objective. The first gives the bright field or direct transmitted image while the second gives the dark field or indirect reflected image. The aperture of the axial beam of the Mikropolychromar does not exceed 0.22 while the annular aperture is between 0.65 and 1.4 when the Zeiss 1.4 aplanatic condenser is used. If the top portion of this condenser is removed and only the low power lower portion N.A. 0.4 is used, then the apertures are reduced to 2/7 of the above values. A blank cover is available to completely stop out the direct beam so that dark field results and annular diaphragms of various outside diameters are used to raise the lower aperture of the indirect beam so that objectives of various numerical apertures can be used.

Color filters fit over the center or axial beam to give the color to the direct or transmitted light. The annular filters are rings which give the respective colors to the indirect or reflected light. Several annular azimuth filters containing segments of red and green filters are also

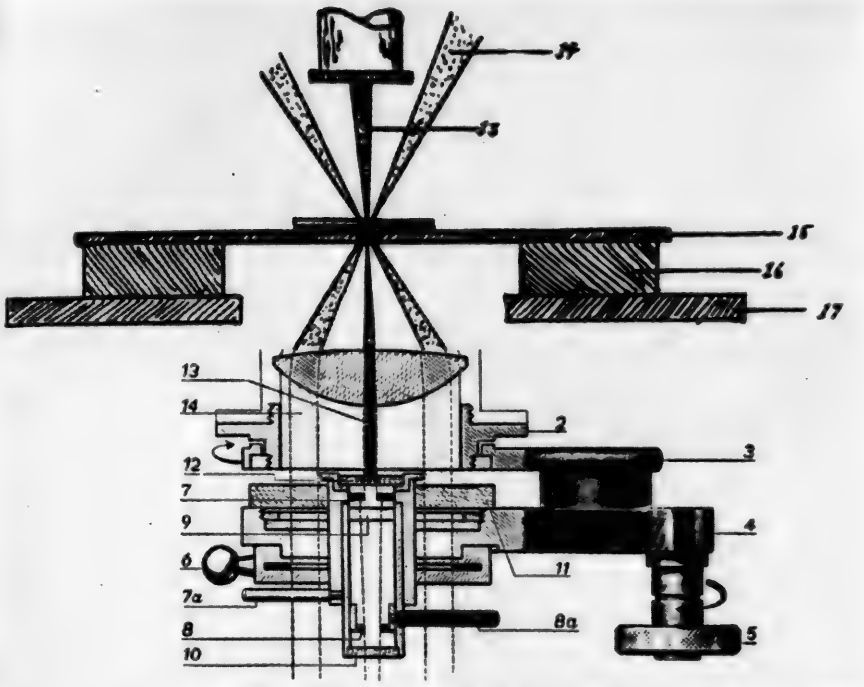

Fig. 2. Diagram of the path of rays in the Mikropolychromar 22615
The refraction at the object slide and cover glass is ignored for the sake of clearness.

EXPLANATION OF FIGURE 2*

1. Condenser.
2. Screw flange of the Mikropolychromar.
3. Carrier of the Mikropolychromar, rotatable about the optical axis.
4. Diaphragm carrier of the Mikropolychromar.
5. Pinion head for swinging out the diaphragm carrier.
6. Diaphragm for limiting the annular beam.
7. Aperture diaphragm of the direct beam.
7a. Lever for operating the aperture diaphragm.
8. Intensity diaphragm for the direct beam.
8a. Lever for operating the intensity diaphragm.
9. Special frosted glass for breaking up the image of the intensity diaphragm.
10. Additional frosted glass (removable).
11. Annular beam filter.
12. Direct beam filter.
13. Direct beam for coloring the whole field of view.
14. Annular beam for coloring the object or its structural elements.
15. Microscope slide.
16. Slide elevator ring.
17. Microscope stage.

*A portion of this photograph has been reproduced from the Carl Zeiss Bulletin Mikro 504e on the Mikropolychromar with their permission.

available so that the light reaching the object from different sides is colored the respective color of the segments.

All of these combinations of color, aperture and intensity control make the Mikropolychromar a very versatile microscope condenser. However, it is possible to make center disc stops and peripheral rings from gelatin filters so as to fit the condenser and objective apertures. Sets mounted in thin glass as 33 mm. discs are available[3]. While these do not give the control offered by the Mikropolychromar, they can be used to obtain quite satisfactory results.

Use of "Optical Staining"

The use of "optical staining" shows to the best advantage when the differences in refractive index in the specimen are great. Mounting of the objects so that the mounting media is quite different in index is of value. The greater the amount of possible reflected light, the greater the detail and intensity of the indirect or dark field image. The use of color to increase the contrast between the direct and reflected images depends upon many factors. It is usually best to use contrasting colors in the axial and annular beams and the exact choice will have to be obtained by trial. When the object itself contains color, a trial of the combinations will be necessary to obtain the best results. Use of contrasting color filters to emphasize the locations of the natural color may be desirable to bring out certain structural detail. Color filters of the same color will tend to minimize the natural colored details. Because of the unnatural results obtained by contrast optical staining of natural colored subjects, often it has been found desirable to use white light in the annular beam and a contrasting color to the natural color in the axial beam. This will give the natural color to the subject but the background will be a contrasting color.

The "optical staining" technic has been used by Lucas[10] in the study made of rubber latices in which moving pictures in color were taken through the microscope. Azimuth filters of several colors in the annular beam made it possible to tell whether the globules of rubber had coalesced or were merely lying over each other. This method of illumination makes possible the differentiation of particles at different depths.

Striations on the surface and in the internal portions of crystals can readily be shown by "optical staining". This may be of interest in connection with the rates of activity in certain chemical reactions and also relative to their physical strength. Similar studies as applied to textile fibers give information relative to the deposition of various textile finishes on their surface. Examinations of very fine colored par-

[10]Francis F. Lucas, Industrial and Engineering Chemistry *34*, 1371 (1942). Motion Picture study of Balata and Hevea Latices with Observations on Buna S and Neoprene Latices.

ticles can be made more distinct because this method of illumination combines both the bright and dark field and in addition the possibility of using contrasting colors. Obviously, "optical staining" cannot replace chemical staining where the differences in structure cause differences in the reaction to the stain. However, "optical staining" is applicable to show and emphasize physical differences in structure which can be made apparent by optical means and to emphasize previously chemically stained materials.

Photomicrography in Color

The results obtained with "optical staining" lend themselves to color photography. In some cases, the results of this method will lead to better black and white pictures, as with the use of filters in ordinary photomicrography, but the beauty and differentiation of the colored object cannot be reproduced satisfactorily in shades of gray. Two factors are particularly important in color photography. They are the exposure time and the color characteristics of the illumination. In this paper, it is not possible to cover the details used in establishing the correct conditions for controlling these factors but the method finally developed for color photography with the Zeiss Mikropolychromar will be given as it is being used at present.

As a source of light, the Bausch and Lomb research lamp with the 6-volt, 108-watt ribbon filament lamp and condenser is used. The Wratten 78B filter is used to correct the color temperature of this lamp to that of the photoflood. Kodachrome Type A 35-mm. film is used in a Leica camera set up with the Leica rotating copying attachment. This is set up over the microscope so that the focusing and exposure can be obtained on the ground glass of the copying attachment. If tungsten or daylight sensitivity Kodachrome or Ansco Color cut film is used, the appropriate filters must be substituted for the Wratten 78B filter so that the approximate color temperature is obtained. For exact focusing on the ground glass, a clear portion and a magnifier are useful.

Photoelectric methods have been used to establish the correct exposure. The method originally used in this laboratory with the Leitz Micro Ibso attachment[11] was changed so as to be adapted to measurement on the ground glass of the copying attachment. A photovoltaic type of photocell (Electrocell, 95 Madison Avenue, New York City) was used in combination with a sensitive Leeds & Northrup type galvanometer having a maximum sensitivity of about 1 x 10-9 amperes per cm. Shunt resistances make this galvanometer a less sensitive meter for measuring higher light values.

The first step in the procedure for photomicrography is to place a ground glass on the stage in place of the specimen and to focus the

[11]Royer, G. L. and Wissemann, M. E., Jour. Biol. Photog. Assoc. *8*, p. 115 (1940).

microscope on this surface. The condenser iris of the lamp is closed almost completely and its image is focused on the ground glass of the copying attachment by raising or lowering the condenser, the mirror being adjusted, if necessary, to center the image in the ground glass of the copying attachment. The filament of the lamp should be centered squarely on the annular beam iris of the Mikropolychromar, the lamp being as close to the mirror as possible in order not to limit the size of the field when low magnifications are used. This set-up is the Köhler method of microscopical illumination. The ground glass, figure 2-10, in the direct beam is removed to provide more light in this beam. The light value is then adjusted to a level known to be correct for the highlights of a microscopical field. In our set-up, this is 300 cm. and the adjustment is obtained by the annular beam diaphragm, figure 2-6, using the correct annular stop for the objective being used. The direct beam iris diaphragms should both be wide open. This establishes the light level for the indirect light.

The ground glass is removed and a clear slide substituted. The light value for the direct beam with the aperture diaphragm open and the intensity diaphragm almost open is approximately as follows for the different filters:

Filter	*Galvanometer deflection*
r 4	250 cm.
b 1	100 cm.
g 3	100 cm.
v 2	100 cm.

These values may vary by ± 30 cm. without any appreciable effect on the background. By changing these values, the brightness of the background can be changed.

The subject is substituted for the slide and after focusing, the exposure is made. With the set-up used in our laboratory, one second exposure is correct for the above light values. The setting of the exposure value on the ground glass establishes the highlight light level and this has been found to be more correct than trying to establish the light level from the actual subjects. They contain varying amounts of non-reflecting material and therefore make a correct average exposure value very difficult to obtain. The above method makes possible the setting of reproducible established light values for both the direct and indirect beams and in our experience has given properly exposed color photomicrographs with the "optical staining" technic.

Photomicrographic Exposure

William R. Berkhofer*

CONTROLLING exposure in photomicrography has more or less been a complicated procedure in both low and high power work. Many complicated formulae have been published, based on the factors of light, lens combination, magnification, filters and speed of film used. The common practice of making test exposures, guessing or judging densities of slide specimen, making computations and hoping they were correctly figured, together with a little good luck, is the part of photomicrography that seems to be antiquated in the light of present day research developments. All methods have their merits, but the thought that started this investigation was, "Could all factors be combined and use a regular photographic light meter at the film plane for exposure determination."

This was a large order and it took eight months of experimenting and research to reach a point where a ray of hope became apparent. Then another four months of tests, checking and rechecking in trying to reach a simple conclusion to eliminate the necessity of complicated formulae in computing exposures when taking photomicrographs.

In endeavoring to describe the findings, no attempt is made to define operations of the photomicrographic apparatus as the technic depends on the particular one in use. However, axial light is of utmost importance, condenser must be properly focused, diaphragm on the condenser and lamp set for the correct numerical aperture of the objective, the specimen and color filter in place and the bellows adjusted for proper magnification. Perfect alignment is essential for good results.

As some photomicrographic set-ups are not as flexible as others, focusing was done on film plane meter readings, so as not to disturb the apparatus when properly set and aligned. Meter readings at the eyepiece or stage necessitated readjusting and were promptly discarded.

Many of the complicated known methods were used, but were eliminated when final exposure system was compiled.

Series of experiments started with two G. E. photographic exposure meters in conjunction with a sensitive galvanometer having a sensitivity of .25 microamperes per millimeter division. Correlating the

*51 North Hillside Place, Ridgewood, N.J. Received for publication November 24, 1944.

galvanometer with the two G. E. meters was the first step. In checking with the General Electric Company, it was found their meters registered 300 microamperes full scale deflection. As they register before and after the scale, their capacity is assumed to be seventy five foot candles although the scale only registers seventy foot candles. By dividing seventy five into 300 microamperes, the result was four microamperes per foot candle. The beginning of the scale is divided into five parts, each representing one foot candle. Note: With a reading glass ½ foot candle can be easily read. With these known factors one was able to compare with the sensitive galvanometer, which registers ten divisions per foot candle with a Photox self generating photoelectric cell. For all practical purposes it proved the low scale values on the G. E. light meter could be used with light controlled to no less than ½ foot candle.

Out of all available film, Contrast Process Pan has been found to be one of the finest for all around photomicrography. It has plenty of latitude, fine grain, all filters can be used and is quite fast. Contrary to the belief that long exposures are necessary, it was found that this film could be controlled through different light values and various exposures. According to the individual's taste, exposures can be made of 1/200 of a second or more at high light values down to 1/4 of a second at a low light value of 1/10 of a foot candle.

Exposure latitude ranges from meter readings of .50 or 1/2 of a foot candle upward at the film plane, through clear glass. A light value of 6/10, 7/10, 8/10 of a foot candle with slide and filters in place, gives a series of film densities at 1/25 of a second. One will be correct and the others will be a little on the light and dark side. All however, will have perfect contrast and holds true for practically any magnification. Illumination is so controlled with color filters and neutral density filters as to give a known meter reading at the film or focal plane.

By trial and error method, at certain foot candle exposures, registered and checked with galvanometer and G. E. meters, an exposure table emerged. At any meter reading within the table range, the correct exposure is obtained. All readings are taken at the film plane, through clear glass, with filters in place, that is, the color filter to control contrast of specimen and neutral density filter for light control.

After the table was worked out, it was necessary to correlate the exposures of certain light values with film speeds, so they could be read on the G. E. exposure meter. To read the meter it is necessary to know three factors.

1 . . . . The f. value to use.

2 . . . . What light value to use.
3 . . . . What film speed to use.

The f. value was arrived at by considering the light value at the film plane in relation to illumination at stage, irrespective of bellows length.

The basic law of "Illumination is inversely proportional to the square of the distance," automatically takes care of the bellows length. As the f. value would be f.1 at the film plane, an unknown value would be at the objective, but still would be proportional to the distance. By controlling the light values through the foot candles registered on the meter at the film plane, full compensation is made for any changes in light, whether it be by neutral density filters at the light source, color filters to control contrast, or density of the specimen.

From exposure tests, it was found, by increasing the film speed rating, correct exposures could be made. Correlating the increased value of four times with the G. E. meter settings, at specific light values was the next step. As the meter calculator does not go much below one foot candle, instead of increasing the film speed four times, the film plane light value was increased four times, so light values could be read on the calculator. This compensated for the increased speed without increasing the film value. By setting at f.1 at a known light value of 7/10 of a foot candle, multiplied by four or at 2.8 foot candles, the exposure reading for a G. E. film speed of sixteen was 1/60 of a second.

By the trial and error method this was found to be too thin and it was through Mr. J. A. Maurer's article "Exposure Control in Photomicrography" published in the June 1944 issue of The Journal of Biological Photographic Association that made it possible to clear the perplexing problem of arriving at the proper conversion film speed to use. Knowing that at a film plane light value of 7/10 of a foot candle, the proper exposure for a film speed of 16 is 1/25 of a second, but the calculator always showed this speed at a film rating of 6.5. Mr. Maurer's modification factor of 40 per cent of the G. E. film rating of 16, or 6.4 checked with the exposure of 1/25 of a second. This was the final step in creating a formula that would check with the exposure table and the G. E. calculator.

The correlated formula follows:

1 . . . Secure film speed . . . As recommended by Mr. J. A. Maurer.
For G. E. rating take 40 percent.
For Weston rating take 50 percent.

2 . . . Read light value on the G. E. light meter with hood off, at the

film plane, without ground glass, with slide and correct color filter in place.

3 . . . Multiply light value four times, to arrive at correct photomicrographic light value to be used on the calculator. G. E. meter *"Cover Open Position"*.

4 . . . Control density of light with neutral density, daylight or ground glass filters at light source.

5 . . . Use f. value of f.1.

Example:

Film used . . . Contrast Process Pan. G. E. rating Tungsten 16. 40 percent of 16 equals 6.4.

Meter reading at film plane . . . 7/10 of a foot candle, multiplied by four . . . or 2.8 foot candles.

f. value . . . f.1.

Set cover open arrow at 2.8 foot candles, set film speed dial at 6.4, read exposure at f.1, and the exposure will be 1/25 of a second.

Note:

Take any light reading at film plane, use the above formula and the result will be found to correspond with the table listed.

Control light so it never goes below ½ of a foot candle, as the reading of the meter scale becomes difficult. A reading glass helps considerably to read light values correctly.

Intense light at the film plane unnecessary as 7/10 of a foot candle only requires an exposure of 1/25 of a second for a slow speed film of 16. Naturally with a higher speed film, exposure is shorter and the same holds true of increased illumination at the film plane.

A simple film speed conversion table is listed, also a table of light densities with the proper exposure for the light value recorded at the film plane. The use of these simplifies the task, but for those who prefer reading directly from the light meter calculator, the formula must be applied.

Histological slides used were prepared at Margaret Hague Maternity Hospital, Jersey City, N. J. They were stained Hematoxylin and Eosin and considered good specimens.

Films developed in DK-11 for five minutes at 65 degrees Fahrenheit.

Film Speed Modification Table

Prepared on the basis of Mr. J. A. Maurer's formula

General Electric Film Speed.

G. E.	8	40%	G. E. 3.2	G. E.	32	40%	G. E. 12.8
	10	"	4.		40	"	16.
	12	"	4.8		50	"	20.
	16	"	6.4		64	"	25.6
	20	"	8.		100	"	40.
	24	"	9.6		128	"	51.2
					200	"	80.

Photomicrographic Exposure Table For General Electric Light Meter

Read with *HOOD OFF* at film plane

Foot Candles	Exposure for MODIFIED G. E. film speeds.				
	G. E. 3	6.5	13	26	50
.35	1/6	1/12	1/25	1/50	1/100
.70	1/12	1/25	1/50	1/100	1/200
1.05	1/18	1/37	1/75	1/150	1/300
1.40	1/25	1/50	1/100	1/200	1/400
2.10	1/37	1/75	1/150	1/300	1/600
2.80	1/50	1/100	1/200	1/400	1/800
3.50	1/62	1/125	1/250	1/500	1/1000
4.20	1/75	1/150	1/300	1/600	———
4.90	1/87	1/175	1/350	1/700	———
5.60	1/100	1/200	1/400	1/800	———

To use G. E. calculator . . . Multiply foot candles four times, and use *Cover Open Arrow* at light values dial.

Note: All readings as close as could be read. High light values at film plane not necessary.

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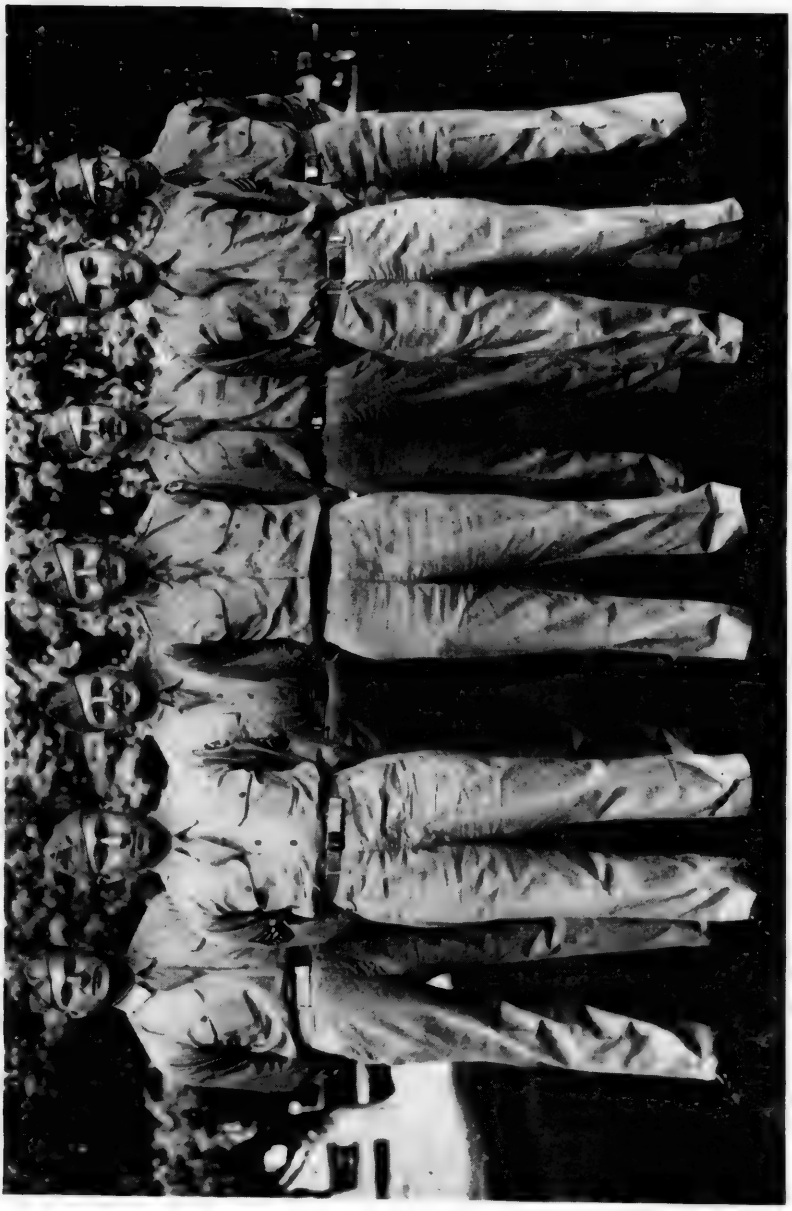


SIXTH DETACHMENT, MAMAS, ITALY

Pfc. Paul J. Sedlock T/Sgt. Sidney Shapiro Sgt. Fred J. Toelle Cpl. Clyde H. Wortham
Sgt. Albert Levin Capt. Charles G. Brownell Sgt. Frank J. Davis

Stand for Polarized Light Photography in Surgery

John Fallon, M.D.*

AN ancient roentgen tube stand was altered, figure 1, by raising it on ten-inch locking casters; by lengthening the horizontal member to 42 inches and steadying it with an overhead truss; by affixing 200 pounds of iron ballast on the op-

Figure 1

posite side of the base inside a wooden cupboard which also stores the polaroid sandwiches (obtained through the courtesy of the American

* From the Fallon Clinic, Worcester, Mass. Received for publication February 5, 1945.

Optical Company), by fastening lights and sandwich-holding frames upon the sliding tube holder; and by making an adapter to hold the camera in the aperture of the tube holder. This adapter, figure 2, has an upright plate with various holes spaced for the tripod sockets of various cameras.

The apparatus was designed for the taking of serial stills of the steps of an operation. Figure 1 shows it set up for this use with Leica,

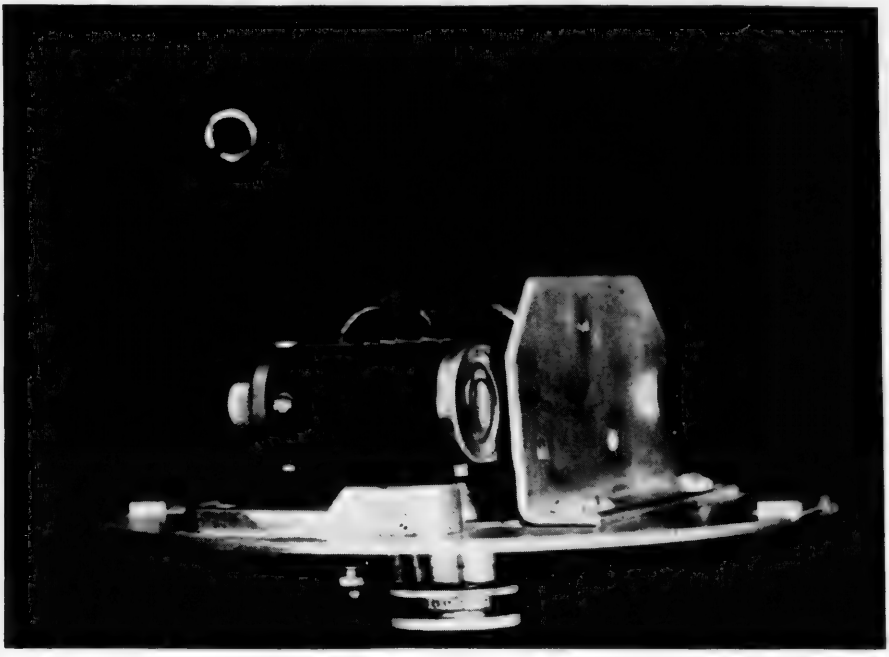


Figure 2

polascreen, remote shutter release and remote winder. Both the latter can be manipulated by sterile strings. Lights are controlled by a foot switch.

For its special purpose the apparatus is efficient. It is overelaborate for ordinary use, clumsy and, despite the ballast, topheavy. Placed across the operating table at either end thereof, and with a bracing leg from the far end of the horizontal member to the floor, it is a reasonably firm cinema stand. It is not applicable, as is, to polarized light cinematography. To keep down size, twelve-inch sheets of polaroid are used and the lights are close to the sandwiches. The polaroid would overheat with more than momentary use of the lights. Possibly water cells could be added to protect them for cinematography.

Infrared Photography*

Leo C. Massopust†

WHEN a beam of white light is allowed to pass through a transparent prism and is reflected on a white surface the beam spreads out into a broad band of rainbow colors. This dispersion of the beam into its constituent colors shows the great complexity of what we call white light.

In studying the visible spectrum, it is to be observed that the outer colors, the violet and deep red, appear to shade gradually into darkness. This darkness is only apparent. In the regions beyond the violet and red bands there are radiations which, though they fail to excite any sensation of luminosity in the eyes of the observer, may nevertheless be found by suitable detectors. These radiations are called, respectively, ultraviolet and infrared. The latter aroused new interest in 1931 when infrared sensitized plates were introduced which could be used as easily as any ordinary photographic plate or film.

The existence of infrared radiations may be demonstrated by placing a sensitive thermometer just beyond the red end of the visible spectrum. A slight rise in temperature will be observed. For this reason infrared radiations are generally considered as heat rays. We have seen how the visible spectrum is characterized by different colors, each color being associated with a definite wavelength but our senses do not tell us much about the special properties of the different wavelength regions of the infrared. The infrared sensitive photographic plate or film has made it possible to explore the infrared region to a limited extent. With the advent of the infrared sensitive emulsion the extension obtained is to about 13 500Å which is about twice as great as the range of the human eye. Although this extension constitutes only the fringe of the entire infrared region, infrared photography has emerged a useful weapon for the practical photographer as well as for the investigator in science and technology.

Materials and Methods

Any ordinary camera may be used to make infrared photographs with the Eastman Infrared Sensitive plate; it is merely necessary to

* Editor's Note: This is the first of a series of articles on fundamental photographic procedures being published in response to popular request.

† From the Department of Art and Photography, Marquette University School of Medicine, Milwaukee 3, Wisconsin. Received for publication February 10, 1945.

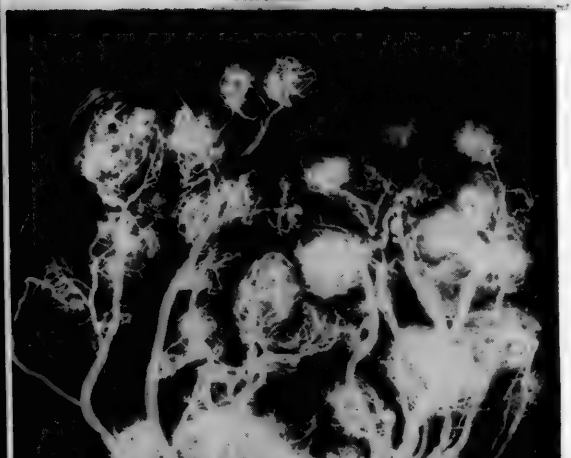


Figure 1. Human placenta. Eastman Superspeed porm film; one second exposure; two 500 watt tungsten bul

Figure 2. Infrared photograph of specimen in figure 1. E man Infrared Sensitive plate; Wratten Number 25 fil ten seconds exposure.

Figure 3. Roentgenogram of figure 1.

Figures 1, 2, and 3 are reprinted from Medical Phy by Otto Glasser.

Figure 4. Ventral aspect of thorax of three months pre para. Two 500 watt tungsten bulbs; Superspeed fil one second exposure.

Figure 5. Infrared Sensitive plate; two seconds exposure

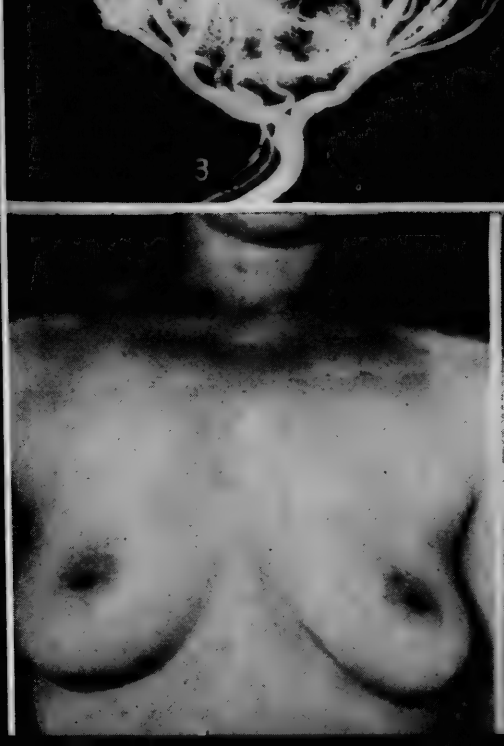
Figure 6. Medial aspect of lower extremity (female). Var cose veins. Superspeed film; two seconds exposure.

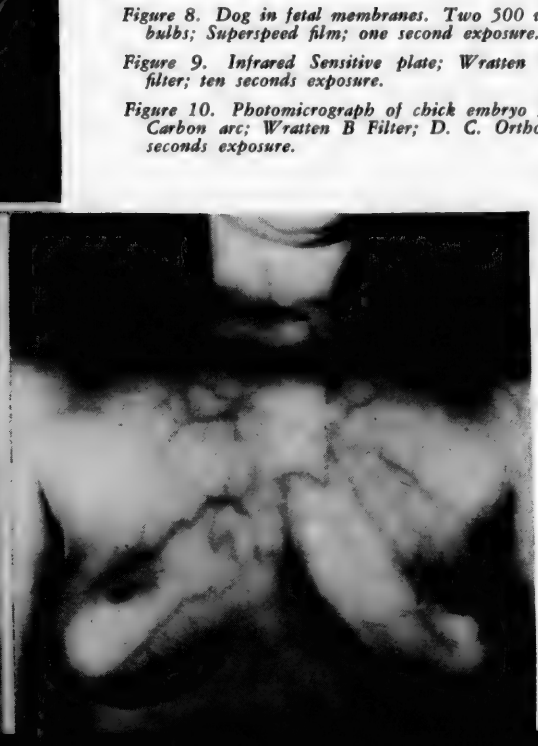
Figure 7. Infrared Sensitive plate; Wratten Number 2 filter; five seconds exposure.

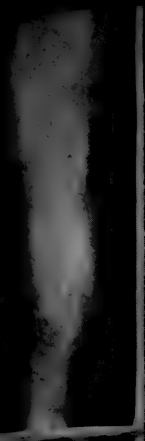
Figure 8. Dog in fetal membranes. Two 500 watt tungste bulbs; Superspeed film; one second exposure.

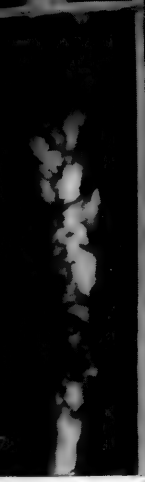
Figure 9. Infrared Sensitive plate; Wratten Number 2 filter; ten seconds exposure.

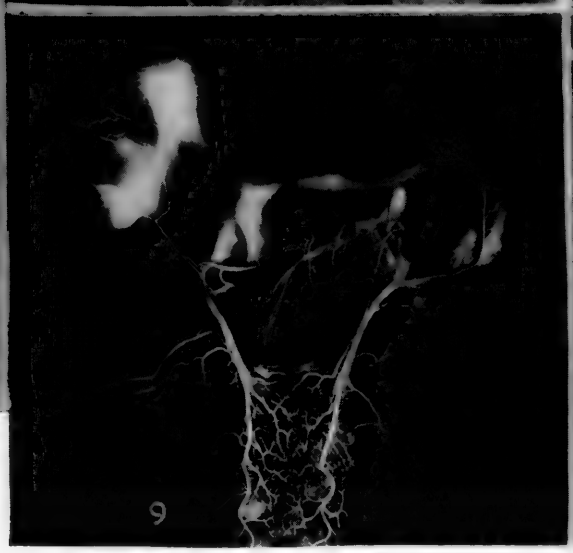
Figure 10. Photomicrograph of chick embryo gross mount Carbon arc; Wratten B Filter; D. C. Ortho plate; fou seconds exposure.









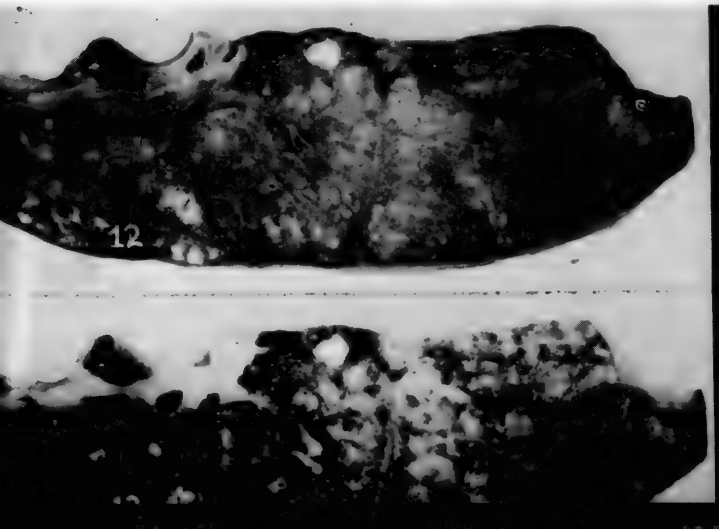


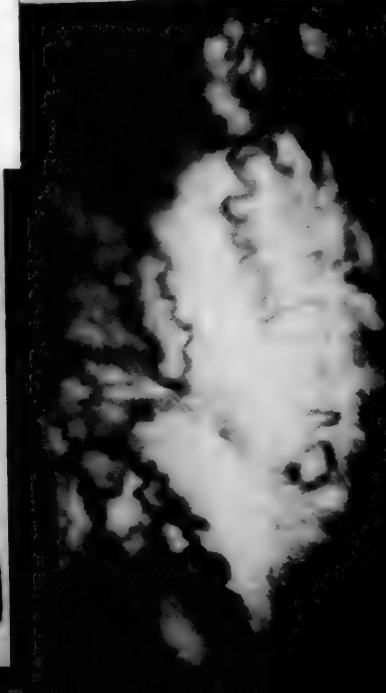
ure 11. Infrared Sensitive plate; Wratten Number 25 filter; one-fifth second exposure.

ure 12. Tuberculous lung. Superspeed film; two 500 watt tungsten bulbs; one second exposure.

ure 13. Infrared Sensitive plate; Wratten Number 25 filter; ten seconds posure.

ure 14. Occlusion of deep vessel. Two 500 watt tungsten bulbs; Infrared ensitive plate; two seconds exposure.





place, over the lens of the camera, a filter which will transmit the infrared rays and will absorb all the violet and blue light to which the plate is sensitive.

A few precautions should be noted. Most bellows are made of artificial leather containing a black pigment and backed by black cloth rendering them opaque to infrared. When old equipment is used the camera bellows should be inspected for leaks. This is done by loading the camera with an infrared plate or film, removing the draw slide and extending the bellows which is then circumscribed with light. The developed plate or film will show fogging if any leak is present.

Many of the older plate holder slides are unsuited for use with the infrared emulsion because they are transparent to infrared rays and consequently will cause fogging. To test a draw slide, the holder is loaded with an infrared plate and covered with the draw slide, an object is placed on the draw slide and exposed for about two minutes and then developed in total darkness. If the draw slide is unsafe an image of the object will appear on the plate. Fogging can also be caused by using shutters made of thin ebonite or hard rubber.

A lens of short focal length at a small aperture is preferred. Long focus lenses may produce out-of-focus pictures. It is advisable at all times to focus visually with the Number 25 Wratten filter in place over the lens.

The red filter, Number 25, is satisfactory for general infrared photography but it does transmit some visible red light; if the exposure is to be confined to the infrared alone a filter which transmits only infrared radiations (Number 87) must be used. The Number 87 filter requires approximately twice the exposure used with the Number 25.

The most convenient and efficient source of illumination is the incandescent tungsten filament lamp. However, any studio lighting or other light sources used for ordinary photography, including sunlight, are suitable for general infrared photography. In illuminating a subject, it is important to strive for a flat illumination of the part to be photographed because the gradation of the infrared plate is so good that even very delicate shades of intensity are clearly rendered. This is demonstrated in figure 7. Note how the shadows of the leg have fallen off when compared with the ordinary photograph, figure 6.

Infrared sensitive plates must be handled and developed in absolute darkness, or with caution by the aid of a Series 3 (green) Wratten safelight.

For average contrast, use one part Eastman Normal Contrast Developer (Formula D-19) and four parts water. Develop four to six

minutes in a tray or seven minutes in a tank at 65 degrees according to contrast desired. Greater or less contrast may be obtained by developing longer or shorter times than those specified. Fix and wash as usual.

Infrared sensitive plates may be kept for months in a cool place under ordinary storage conditions.

Applications

A photograph made by infrared rays shows characteristics strikingly different from one made by visible light. The flesh appears chalky, the red lips are light, the eyes show as black circles and all lines in the face are greatly emphasized.

It has been known and accepted for some time that infrared radiations can penetrate the skin. Because of this penetration it is apparent that the absorption and reflection properties of the skin for infrared rays are different than those for visible light, being effected by pigmentation, body tissue and fluids, and growths of hair.

Infrared photography has proved useful in the study of varicose veins, superficial tumors, cirrhosis, and thrombosis of blood vessels with subsequent changes in the superficial collateral circulation. In other words it is of value in any condition where the opacity of the skin prevents making clear photographs. It has little value in dermatology unless the skin condition involves superficial blood vessels.

Since infrared photography necessitates comparatively long exposures, movement and breathing should always be controlled by a method suitable for the part to be photographed.

It should be noted that in infrared photography profuse growths of hair on the extremities, thorax and abdomen obscure practically all underlying skin surface. Removal of the hair will aid in producing clear photographs.

Visualization of Superficial Blood Vessels.

That there is an increase in the size and conspicuousness of the superficial vessels in the breasts and abdomen during pregnancy is an established fact. Infrared photography has made it possible to record the normal patterns as well as any vascular changes, thereby furnishing a permanent photographic record for comparison during the progression of the pregnancy, figure 5.

The same is true of any peripheral vascular pathology. A particularly interesting application is found when a large deep venous trunk is

obstructed and a pressure load is thrown on the superficial veins causing them to become distended and tortuous, figure 14.

Gross Specimens.

Owing to the lack of color contrasts in some tissues the results obtained with ordinary photographic materials and methods have been most discouraging. In some types of pathologic lung tissue it is almost impossible to demonstrate photographically the color contrasts between the normal tissue and the tissue showing pathologic lesions, figure 12. Infrared photography reveals details of structures in some tissues in which the ordinary photographic methods fail, figure 13. In these photographs, reflected light from a 500 watt tungsten lamp was used. Figures 8 and 9 represent another illustration of results obtained with reflected light by the infrared method. The fetal dog within its membranes which is only slightly visible in the ordinary photograph is clearly shown in the infrared photograph.

Infrared photography can also be applied in the photography of a fresh specimen in which the blood vessels are injected with a contrasting color media. In figure 1, 2 and 3, the arteries of the placenta were injected with red cinnabar according to the technic of Swindle[1], while the veins were injected with cinnabar to which india ink was added. Figure 1 does not distinguish the almost imperceptible difference in color between the arteries and veins. The infrared photograph, figure 2, reveals excellent contrast, the arteries are white, the veins black. Since cinnabar, a mercuric compound, is radiopaque, good roentgenograms can be made at intervals to determine the completeness of the injection, figure 3.

Photomicrography.

Photomicrographs obtained with transmitted or reflected light with the infrared plate are more enlightening in some instances because of the greater transparency and definition of structure obtainable. Figure 10 is the ordinary photomicrograph of a chick embryo gross mount, stained with carmine. Improvement in definition of structure obtained with the infrared method of photography is shown in figure 11. The use of the infrared method is especially valuable when photographing routine microscopic sections of tissues which are heavily stained with

[1]Swindle, P. F.: The Architecture of the Blood Vascular Networks in the Erectile and Secretory Lining of the Nasal Passages. Ann. Otol., Rhin. and Laryng. 44:913-32. 1935.

any of the red or brown stains, or in tissue where the natural pigment is reddish or brownish in color.

SUMMARY

1. Infrared photography demonstrates the variable patterns in the superficial vascular system in the living and furnishes a permanent photographic record of any progressive or regressive change in these patterns.

2. With infrared photography very slight differences in the color and morphologic detail of gross specimens may be recorded with excellent contrast.

3. Infrared photography amplifies existing methods by permitting photographs to be obtained with transmitted light in cases in which visible light does not penetrate.

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☆

BUY WAR BONDS AND STAMPS

☆

Photographic Technic in the Operating Room

Howard R. Trissel*

SURGICAL photography, up to the present time, has been limited by the requirements of asepsis in the operating rooms of modern hospitals. Some photographic apparatus has been developed that could be considered completely sterile, and therefore permissible for use in close proximity to a surgical field.

One of the accepted ways to procure actual photographs of operating procedure has been through an arrangement of suspended or correctly placed mirrors or reflectors, over or near the operating table, in conjunction with camera, flash or photoflood equipment, and a telephoto lens; the camera being located remotely from the immediate surgical area. While this method is a means of permitting surgical photography, it can not be considered as completely desirable, nor can it be considered as sterile equipment, although the operator might conform to the requirements of maintaining an aseptic atmosphere by donning sterile garments. But his ability to take satisfactory photographs depended upon the movements of the surgeon and his immediate assisting staff. No one but the operating surgeon knows when the precise moment for making photographic record of operating procedure is at hand.

The elements of timing, simplicity of camera manipulation and the necessity for maintaining an atmosphere of asepsis, formed the basis for the development of the Alphatron Surgiscope. To be satisfactory from the standpoint of taking surgical and medical photographs, the camera must be instantly available for quick action, since the life and safety of the patient can not be considered secondary to the need for obtaining medical photographs.

The camera must produce reliable photographs with an absolute minimum of manipulation . . . it should approximate the pointing of a camera and pressing a button. To maintain an atmosphere of asepsis, the camera actually should be a surgically sterile instrument in the

*Adel Precision Products Corp., Burbank, California. Delivered before the Biological Photographic Association, Inc., Binghamton, N.Y., September, 1944. Received for publication January 20, 1945.

hands of the operating surgeon or his assistant to be used when the need for an actual photographic record presents itself.

To the best of our knowledge, no camera has been developed up to the present time that can be subjected to the sterilization technic of the standard hospital autoclave. It is doubtful whether such a camera could ever be produced. The only answer to the problem of producing a photographic mechanism that could be used as a surgically sterile instrument, is the placement of a camera, precise in its functioning, simple in operation, within a sterilizable housing.

This is what has been done in the production of the Alphatron Surgiscope. While the Alphatron camera and its Surgiscope housing are two distinctly separate units, they are integrated into a functional unit that permits the taking of an unsterile camera into the operating room within its sterile housing.

The Surgiscope is light in weight, made of aluminum and chrome plated. It is machined with utter simplicity of line; no crevices, no hard-to-clean areas, no complicated construction. Inside the housing, shielding the camera, is a sealed partition of fire-proof glass. The viewing window is also of this same type of glass. The entire housing can be placed in the autoclave for complete sterilization along with necessary surgical instruments.

When ready for the operating room, a sterile attendant handles the Surgiscope housing. An unsterile attendant then places the properly set and focused Alphatron camera into the top section. The camera and multiple flash-bulb unit now assembles easily into its sterile housing. The unsterile attendant has absolutely no contact with the Surgiscope housing. He touches the camera only.

After the camera unit is slipped in place, the sterile attendant closes the hood, and the camera is ready to be taken to the operating room for placement on an instrument table within reach of the surgeon. The camera and Surgiscope together weigh little more than the average flash-gun equipped camera.

To obtain perfect color reproduction of the operating field, or of any unusual conditions that might arise during the surgical procedure, the surgeon reaches to the table, picks up the Surgiscope by its two handles with the release button under his thumb. Placing the balancing plate against his forehead, he views the field through the large pyrex window, the bottom of the Surgiscope is held approximately 3 inches above the operating field. The picture area is selected and then by pressing the button under his thumb, a foolproof flash picture, either in color or black and white is taken within a few seconds. There is no dangerous time lag. Eight consecutive flash bulb

pictures may be taken without reloading. The dial control on the side of the housing automatically indicates the picture and flash bulb sequence.

The Alphatron camera is precisely engineered by technicians who are accustomed to amazingly accurate tolerances in the production of hydraulic and electrically controlled equipment for aircraft. It is small, built of lightweight aluminum alloys throughout, with a flash bulb mechanism that is mechanically timed within the camera. Even the batteries are inside.

Separated from its Surgiscope housing, the Alphatron becomes an all-purpose camera, without need for auxilliary equipment, except for various filters adapted to certain atmospheric conditions. There are no filter requirements in the surgical use of the Alphatron.

Being a true reflex camera, it permits viewing an image produced by the photographic lens, with no parallax error. The unique feature of the optical system being that the viewed image is of constant brilliance, regardless of lens aperture, and compares favorably with the vision of the unaided eye.

When preparing the camera for operating room use, and before placing it in its sterilized housing, the attendant makes two simple dial settings, sees to it that fresh flash bulbs are arranged in place, and that it is properly loaded with film. That is all the preparation necessary. The camera uses two standard film sizes in both color and black and white.

Its use offers wide application as an aid in visual education. The new developments of the war era have shown the need for quick impression power of the visual image—in the training of men for battle, and in training millions of new workers at new jobs. It is obvious that educators in the medical field have felt the need for visual films as an adjunct to their classroom lectures.

If the Chinese adage concerning the value of one photograph as opposed to 10,000 words is accepted as an actuality, then one colored medical photograph in the classroom is worth ten times 10,000 words.

It is conceded that color films of actual operating technic, shown in conjunction with a classroom lecture, provide vivid impression and memory of the subject concerned, that would ordinarily require thousands of words with less retentive results on the part of students.

The use of color films in recognizing tissue and tissue changes, areas of discoloration and inflammation, abnormal growths, and all other pathological conditions, is a tremendous field in visual education.

Dermatology is another important field, where color studies of various skin diseases would be a vital asset to the instructor. This is a

particularly interesting possibility, now that global war has made recognition of tropical and geographical diseases imperative, in both private practice and educational institutions, since so many of these diseases fall into the dermatosis field.

Color film records of all major surgical procedures in hospitals will be a part of the patient's permanent hospital record. There have been many occasions when litigation has been avoided by possession of photographic records, keyed to case history.

Because of its flexible use, the Alphatron is an ideal laboratory camera. Its simplicity provides ready assistance for all types of photomicrography and photography in routine laboratory procedure, and in research developments.

Book Review

THE AMERICAN ANNUAL OF PHOTOGRAPHY 1945 VOLUME 59. Editors Frank R. Fraprie F.R.P.S. and Franklin I. Jordan F.R.P.S. American Photographic Publishing Company, Boston, Mass. 240 pages. 77 pictorial illustrations plus many textual illustrations. Paper $1.50. Cloth $2.25.

In keeping with the rapidity of advancement of Color Photography, Lloyd Varden, a member of the B. P. A., is given first place in this publication. His "Aspects of Color" is an excellent article and is followed by a selected bibliography. Herbert McKay authored a practical "down to earth" "Teach Yourself Photography" that will start some serious thinking along educational lines. Albert Sadler of the Eloise Hospital, Eloise, Michigan, another one of our B. P. A. members contributes an article of unusual interest to our members on "Medical Photography" with some outstanding illustrations.

Various other fields are covered by other writers. We commend the excellence of the selection of the Pictorial Illustrations as well as the pictures themselves. Any serious photographic student, professional, or amateur will profit by a careful reading of this Annual. We are glad to see the National Salon statistics continued, as well as a "Who's Who in Color," and a "Who's Who in Nature Photography"—both new listings should be continued. The Editors are to be commended on the high standard of our American Annual.

Ray Miess.

Eleventh Report of the Committee on Motion Pictures, 1944

I. *Films reported by our members.*

Allen Hancock: Treatment of varicose veins (600'); Extraperitoneal closure of colostomy (400'); Demonstration of Wangensteen suction method (200'); Surgical ward procedure (200'). All 16 mm. Kodachrome.

B. M. Loden: Microscopical diagnosis of human malaria. 16 mm. made for U.S.P.H.A.

Adolph Nichtenhauser: Neurological cinematographic atlas by Dr. S. P. Goodhart. 20 reels being revised.

Robert A. Sage: A technique for skin grafting—instruments and procedures. 16 mm. Kodachrome made for Dr. E. J. Poth.

II. *Items of interest.*

Frank E. Hart reports that their new Hi-Speed Fastex 16 mm. camera with a speed of 4000 frames/second is revealing interesting discoveries in engineering.

Henry Roger wrote that he is doing microcinematographic research on various foods with a miniature baking oven for the American Film Center and Swift and Co. He also reports using Electronic control of the camera for eye photography in psychiatric research.

The Baruch Committee Report on Physical Medicine, April 1944, contained the following statement: "Promotion of teaching of and research in physical medicine in all approved medical schools, i. Support be given to the building up of a medical film library and of other visual and pedagogic aids dealing with various phases of physical medicine and with physical rehabilitation". p. 15.

Dr. A. Pijper writes that the South African Association for the Advancement of Science unanimously passed a resolution to ask the Government to establish " * * * a State Film Institute, which would make scientific films under the direction of scientists, assist private and institutional scientists in the making of scientific films and serve as a bureau for the collection, and distribution of scientific films, on an international basis".

The Scientific Film Association % Royal Photographic Society, 16, Princes Gate, London S.W. 7, have distributed a memorandum on THE CLASSIFICATION, APPRAISAL AND GRADING OF SCIENTIFIC FILMS. The first section considers documentation under the headings of data, content, accuracy and comprehensiveness of content, and appraisal in relation to the type of audiences likely to see it. The second part considers the viewing and evaluating of films. "It is proposed that in each place where films are to be appraised, there shall be a *Viewing Panel* from which *Appraisal Groups* shall be selected to view particular programmes of films, and a standing *Appraisal Committee* to select the films to be viewed, to make up suitably constituted *Appraisal Groups,* to consider the recorded opinions of members of each *Appraisal Group* and from these to recommend a *Grading* for each film". The duties of these groups are given in detail with means for doing them and report forms. An Appendix defines the terms used in the report and by the members of the grading groups.

This is a concrete proposal to catalog and evaluate films that should be considered and with some modification might well become a basis for doing the same in this country. They propose a permanent organization with a paid secretary to relate all of the groups concerned with films. (The British are making more progress in this field than we are, despite the war!)

III. *Catalogs.*

Cook, D. E. & E. Rahbek-Smith. Educational film catalog. 4th ed. 1944. H. V. Wilson Co., New York 1, N.Y. ix+449 pp. Monthly supplements are issued and an annual revision is proposed.

Films on surgery. 13th ed. 1943. 16 pp. Davis and Geck, Inc., 57 Willoughby St., Brooklyn 1, N.Y. 16 mm. films*.

Motion pictures from the Lederle Film Library. Lederle Laboratories, Inc., 30 Rockefeller Plaza, New York 20, N.Y. 16 mm. some in Kodachrome*.

Nichtenhauser, A. New Health Films. 2nd Suppl. American Film Center, 45 Rockefeller Plaza, New York 20, N.Y 20. An annotated description of 26 films.

Society of American Bacteriologist, Dr. H. E. Morton, Univ. of Penn., Philadelphia 4, Pa., now lists 112 films. (*Cf. J. Biol. Photogr. Assoc.,* 1944, 12:189 for details of their service).

*Films restricted in distribution to the professions, medical schools, etc.

IV. *Publications of interest.*

Anon. Making and presentation of scientific films. *Nature,* 1944, 154:243-244.

Bell, G. The scientific outlook and its presentation by films. *Nature,* 1944, 154:155-157. Quote: "But the film medium like all scientific tools, is powerful for ill as well as good. It does not necessarily tell the truth—indeed there are certain fundamental difficulties in the way of its doing so. The viewing and appraising of films which deal with science is therefore an important task". p. 157.

Nichtenhauser, A. Planned health film production. *J. Hlth. & Phys. Ed.,* May, 1944. 4 pp. in reprint.

——Notes on motion pictures seen at the annual session of the American Medical Association Chicago, June 12-16, 1944. *American Film Center,* 1944. 7 pp. mimeogr.

Lester V. Bergman,
Oscar W. Richards, Chairman,
19 Doat St., Buffalo 11, N.Y.

CURRENT PHOTOGRAPHIC ABSTRACTS

Microfilm Reader-Projector [Federal Mfg. Engineering Corp.]. *Scientific Amer.,* 171: 84, August, 1944. A portable microfilm reader-projector, weighing 8½ pounds, is briefly described. The reader-projector requires only three or four feet of space for projection, and is said to allow 24 times magnification without loss of sharpness. The apparatus accommodates 35-mm. roll or strip microfilm, and takes standard projection lamps up to 200 watts. The reader-projector can be used to view short lengths of microfilm by unscrewing the reel holder. A photograph of the instrument is reproduced.

K. G.

The Kodatron Speedlamp. G. A. Jones. *Electronic Engineering,* 17:16-18, June, 1944. The Kodatron Speedlamp is described. The circuit diagram of the electrical portion of the unit is shown along with an intensity-time curve for a No. 1 lamp with a condenser capacity of 112 mfd. The author points out that the measurement of the duration time for the flash is complicated by the fact that the intensity of the light falls away progressively less rapidly, leaving a pronounced tail. Consequently, if a full exposure is made wih the light, the effective time of duration is longer than that when the exposure is less. This explains why in photographs showing both light and dark objects moving together, the light ones appear less sharp than the dark ones. Photographs reproduced include a spectral-energy distribution curve of the discharge tube, ranging from 3000 A. to 10,000 A., and exposures made with the Kodatron Speedlamp.

C. R. A.

Conserve Your Photofloods with a Homemade Dimmer. J. R. Oswald. *Amer. Cinematographer,* 25: 65, February, 1944. A simple "series-parallel" control for dimming two Photoflood lamps during focusing is described. A photograph and a wiring diagram are included. When the double-pole, double-throw toggle switch is thrown to the left, the Photofloods are on dim, their brilliancy approximately equaling a 60-watt lamp. With the switch thrown to the right, the lamps light to full brilliancy. The two single-pole, single-throw toggle switches are merely for controlling the Photofloods independently when on bright. If these switches are used, they must both be thrown to the "on" position in order to have the lamps light at all, when on "dim." This is necessary to complete the "series" circuit, in which the two Photofloods must also be used, in order for either one to light. The remaining single-pole, single-throw toggle switch is simply an "on" and "off" line switch to control the a.c. current for the entire box.

C. J. K.

The Photomicrography of Living Specimens. K. D. Froome and B. A. Jarrett. *Phot. J.,* 83: 352-53, September, 1943. For the photomicrography of living specimens of pond life, with times of exposure of 1/50th second and less,

the authors use a special electromagnetic shutter vane which is moved aside out of the beam by a magnet energized by current from a motor-driven timer placed on the floor. The light vane carries a fragment of optically plane glass which reflects the image into a viewing eyepiece while the shutter is closed, enabling the object to be kept in the field and in focus up to the instant of exposure. Motion-picture film is used for the negatives and enlarged five times for the final prints. C. H. S

Color Microscopy in Ultraviolet Rays. E. M. Brumberg. *Nature,* 152:357, Sept. 25, 1943. A reflection objective for ultraviolet rays (having a numerical aperture of 0.50, and an *f*-value = 6 mm.) was constructed at the State Optical Institute, Leningrad, which allows the use of a broad spectral region in the ultraviolet. The objective was used for making conventional color photomicrographs in which three separation negatives made at three wavelengths in the ultraviolet are printed in the usual subtractive colors of natural-color photography, so that the result in effect translates the invisible ultraviolet picture into the visible region. As an extension of this principle, methods have been worked out for direct color vision in the ultraviolet. In one, a fluorescent screen is employed with three pigments which differ in the color of their fluorescence as well as in their excitation region; in another, two rotating disks are used, each of which carries three filters. Each filter of the first set passes a certain part of the ultraviolet spectrum and allows it to excite a fluorescent screen, while each of the second set transmits one of the three primary colors to the eye from the white fluorescence of the screen. The two sets are rotated together so as to produce a continuous picture to the eye. C. H. S.

Recent Developments in Light Sources. P. S. Millar. *Elec. Engineering,* 63: 126-38, April, 1944. Recent advances in the field of illumination before the war and the probable postwar developments and applications are discussed. Arc, tungsten-filament incandescent, infrared, mercury-vapor, sodium-vapor, and fluorescent lamps are considered in detail. (Author's Abstract)

"Coke Oven" Makes Good. *Brit. J. Phot.,* 90: 213, June 11, 1943. Two press photographers, A. Allam and H. Bush, from the *London Daily Express,* photographed the French coast from Dover with a homemade long-focus camera, the "Coke Oven," 10 feet long, on infrared material R. S. S.

New Profitable Markets Opened by Three-Dimensional Pictures. *Phot. Trade News,* 8: 42-3, May, 1944. General details are given for making Vectographs. Two negatives are made either in a stereoscopic camera or with two exposures of a motionless object from two positions. Two negatives (one reversed) are transferred to wash-off relief films which are hinged, emulsion to emulsion. The hinged reliefs are soaked in a special printing solution, a sheet of Vectograph film is placed between them, and the sandwich is run through a wringer. The reliefs are then peeled off the Vectograph film, which now has the two images on its opposite surfaces. When this film is examined through polarizing spectacles, a stereoscopic image can be seen. The Vectograph may be projected on a screen or examined in the hand. Vectographs have been used for instruction in the repair and assembly of machines, the wiring of electrical apparatus, etc. G. E. M.

Photography and the Standardization of Defects. *Brit. J. Phot.,* 90: 308, Aug. 20, 1943. Natural-size photographs of plywood have been included in a new British Standard Specification (High Strength Plywood for Aircraft—6V.3-1943) with the object of indicating the limits to which various defects will be tolerated. R. S. S.

Association News

POSITIONS OPEN FOR MEDICAL PHOTOGRAPHERS

Interest in medical photography is growing rapidly. Several positions are open for full-time medical photographers, to take charge of photography in institutions or for individual doctors. If you know anyone experienced in photography, preferably medical photography, who might want further details about these positions, have them get in touch with the Secretary of the Biological Photographic Association, University Office, Magee Hospital, Pittsburgh 13, Pa.

OUR NEW MEMBERSHIP LIST

Members who received the Association's first printed membership list in 1941 will notice that a healthy growth is evident in the present list which accompanied the December 1944 number. We are a third again as large as we were in 1941.

It may be remembered that at the Philadelphia 1938 Convention we determined to have an informal membership drive, and we asked every member to bring in one new member. The honor-list of members who complied is a long one. At the head of that list are five members who brought in ten or more new members each. They are: Capt. Ralph Creer, Mr. Joseph Haulenbeek, Mr. Leo Massopust, Dr. Oscar Richards, Mr. Louis Schmidt. Mr. Schmidt is the leader among the leaders, having brought in 32 new members between the 1938 Convention and the beginning of the present membership year. Other members may have been directly or indirectly responsible for bringing in ten or more new members, but unless their names appeared as sponsors on the new members' applications, we have no way of keeping track. The Chicago Chapter deserves recognition for its collective work in bringing in new members.

Our growth has not been centralized in any one part of the country. New York State's membership has grown the most numerically, but its percentage of growth since 1941 is less than 50 per cent. States that have grown by more than 50 per cent since that time are: California, District of Columbia, Illinois, New Jersey, Texas and Washington. It is interesting that in spite of the difficulty of corresponding and transacting business with members in other countries, our foreign membership has grown by nearly 50 per cent.

As before, our greatest concentration is in the northeast. The area comprising New England, New York, New Jersey and Pennsylvania

accounts for 42 per cent of our membership. The next most populated region is a square that has as its four corners Michigan, Indiana, Missouri and Minnesota; 28 per cent of our members live in this area.

PHOTOGRAPHY IN THE ARMY

The armed service has trained many new photographers and given some experienced photographers new interests. We have had several letters from abroad asking about the field of biological photography and how the necessary training can be acquired after the war.

We also have letters from service men doing photographic work in this country. One army photographer at a large General Hospital writes that he and another photographer take pictures of gross specimens; pre-operative and post-operative cases; clinical material; autopsies; copies; lantern slides of X-rays; medical charts; orthopedic braces, casts and apparatus. Some pictures of patients in the Occupational Therapy Clinic are also photographed. These particular photographers have not done much photomicrography but they see it coming soon.

At present the pictures are used by the medical officers to illustrate lectures at medical meetings. And these medical officers will undoubtedly be champions for visual aids when they return to their peacetime practice. Thus it is not only the photographers who are learning about medical photography in this war.

DATA OBTAINED FROM QUESTIONNAIRES

When the former Chairman of our Questionnaire Committee, Capt. C. Graham Eddy, went abroad with the first Museum and Medical Arts Unit, he had analyzed and summarized the responses on 161 questionnaires filled in by our members. Mr. Arthur Smith of Cornell University took over the questionnaires and at present 206 have been analyzed. Cards have been made out for the members who responded, and each card shows at a glance the range of interests and the status of the photographer; his routine and specialized photography; the types of cameras he uses; the media in which he works; whether he uses lantern slides and if so what sizes; whether he does motion picture work; and the uses to which his pictures are put. On the back of the card is space to describe specialized technics, list publications and activities, and to add other notes. These cards furnish a valuable reference-source for the activities and interests of our members.

A preliminary survey discloses several interesting facts. One is the large and growing interest in photomicrography. When Capt. Eddy summarized the 161 responses in 1942, roughly 40% of the responding members listed photomicrography as an occupation or an interest.

In the present summary 53 per cent of the questionnaires listed photomicrography. In that short time it has out-stripped the interest in motion pictures which now appears on 42 per cent of responses, though formerly it was on 58 per cent. The difficulty of obtaining motion picture film is undoubtedly reflected in this drop.

The users of lantern slides are about equally divided between standard and 2x2 in. On the whole, standard slides take the lead by a slim majority—48 per cent of the total responding membership against 45 per cent listing miniature slides. Some members of course are included in both these groups, as they list both types of slides. It is interesting that although standard slides have this slim edge over miniatures, 65 per cent of the responding membership stated they had miniature equipment.

The most frequently-listed purposes for which photographs were made were: records, publication and teaching, in the order named. Only about a sixth of the answers listed research as an objective.

Although complete enough for general references, the cards give only an outline of the information to be found in the questionnaires themselves. There one can find listed not only the range of the photographer's interests and the types of cameras owned, but also the type of illumination and the media used for each kind of work, the preferred negative and print sizes, descriptions of specially built equipment, etc. This information will be so valuable that it is to be hoped a greater and greater percentage of the entering members will take the trouble to fill out the questionnaires as time goes on.

Predictions are always dangerous, but it seems at least likely that after the war the percentage listing motion pictures as an interest will increase rapidly, overtaking, and perhaps topping photomicrography; that more than the present scattered interest in stereoscopic pictures will be seen; that endoscopic and other types of specialized work will increase, and that research will be listed more often as the purpose behind the photograph.

NEED ME?

A scientific photographer and member of the BPA, owning several still cameras, a Cine Special movie camera, photomicrography and other equipment, is interested in establishing a department of photography for a medical college or hospital or in locating with an established medical photographic laboratory. For further details please correspond with

Wynne S. Eastman
117 Sixteenth Street S.E.
Cedar Rapids, Iowa.

SUSTAINING MEMBERS

Some individuals who have a deep interest in the advance of scientific photography help finance a wider range of activities for the Association by becoming Sustaining Members. The privileges of Regular and Sustaining Members are the same. Either type may be chosen each year when the dues are payable.

Cammon, W. A. "Don", D.O.S.
Cameron Surgical Specialty Co.
666 West Division Street
Chicago 10, Ill.

Davidson, Emil
Clay-Adams Company
44 E. 23rd St.
New York 10, N.Y.

Flory, Louis Paul
Boyce Thompson Institute
for Plant Research
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Garner, Dr. Jay M.
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Winnetka, Ill.

Gibson, H. Lou
Eastman Kodak Company
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Hagaman, R. S.
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Edwal Laboratories, Inc.
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Horton, Nathan S.
Ayerst, McKenna & Harrison, Ltd.
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Smith, James
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Varden, Lloyd E.
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Precision Brings Pacific Victories

Aimed with deadly precision, aerial torpedoes have been a decisive factor in Pacific victories.

Early in the war, U. S. Navy Torpedo Squadrons launched their "tin fish" by diving in dangerously close to their target. The risks were great—but they sank plenty of Jap ships.

The problem in this type of attack is to estimate the distance to the target and the speed of the target. He must aim —not where the ship is, but where it will be when the torpedo strikes.

To solve this problem, he uses a Torpedo Director in which an enemy ship can be centered easily and quickly.

The Torpedo Director is one of many scientific optical instruments being produced by Spencer Lens Company to speed Allied victory.

Spencer LENS COMPANY
BUFFALO, NEW YORK
SCIENTIFIC INSTRUMENT DIVISION OF
AMERICAN OPTICAL COMPANY

FORESTRY

The Journal of the Biological Photographic Association

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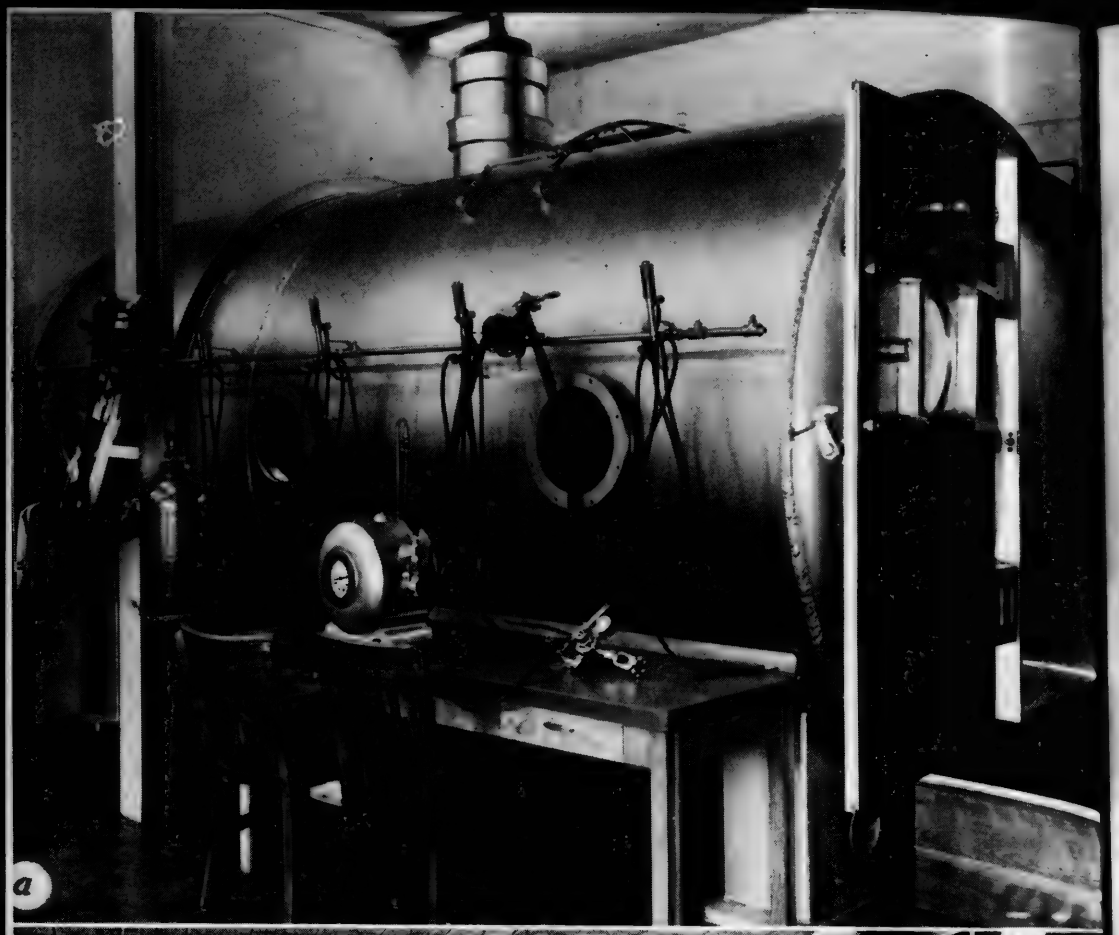

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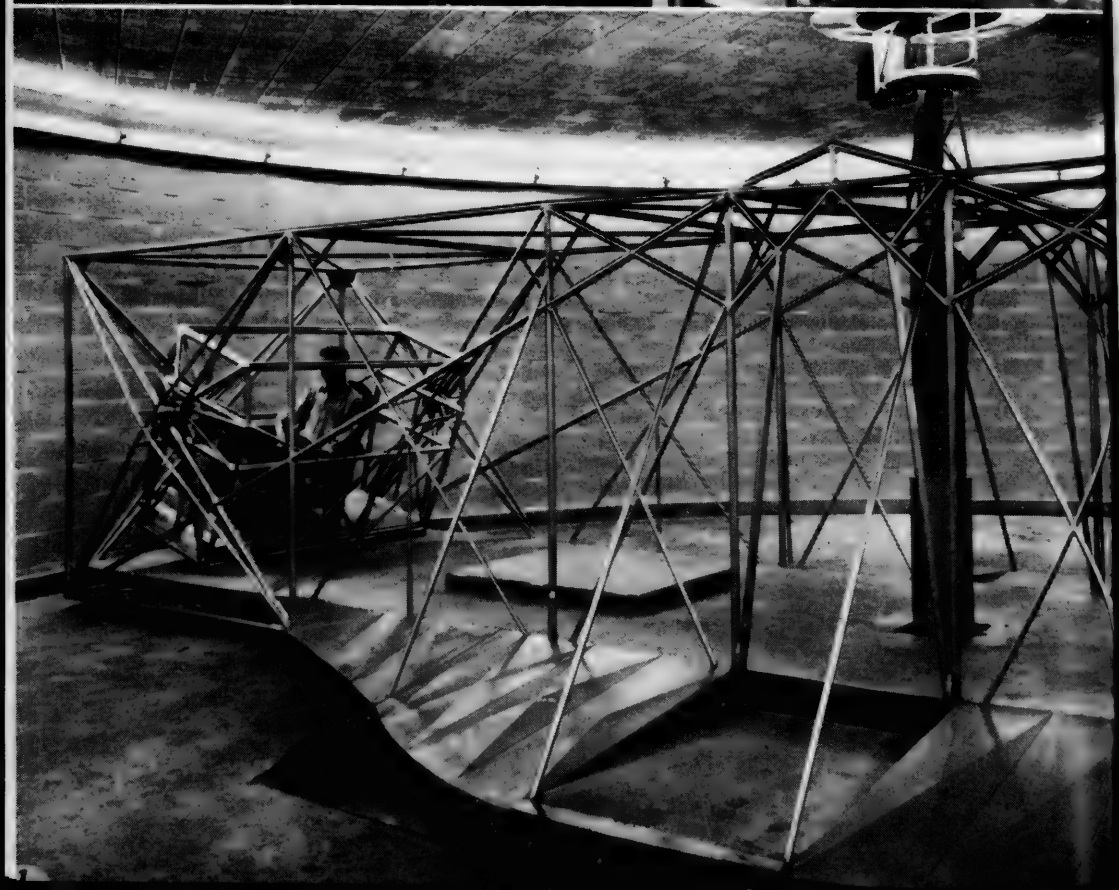


Experiences with Photography in Aviation Medicine

Lardner A. Coffey *

FOR seven years the Mayo Clinic has devoted considerable attention to research in aviation medicine. In July, 1942, less than seven months after Pearl Harbor, intensive investigation began in a building constructed to accommodate the elaborate apparatus and equipment necessary for this form of research. Prior to Pearl Harbor the Photographic Department at the clinic was frequently requested to produce photographs illustrating material pertaining to research in aviation medicine. After Pearl Harbor when this program of investigation and experimentation expanded, the demand for photographic service increased. This form of research has produced unique subject material and conditions adverse to good photography and thus singular photographic problems have been encountered.

Some knowledge of aviation medicine is essential to an understanding of the problems of photography in this field. Aviation medicine is the study of the effect of flight in air on the human body. Our powerful military airplanes operate at high altitudes where man, if unprotected, cannot live. At an altitude of 30,000 feet there is insufficient oxygen to keep a candle burning. At this altitude the thermometer often registers 40°F. or more below zero. In addition to these two difficulties a third danger exists. It is known to pilots and Air Corps personnel as "g," which stands for gravity. The modern fighter airplane is highly maneuverable and is capable of great speed. This speed combined with certain maneuvers produces an effect not unlike that produced when we, as children, whirled a stone tied to the end of a string. The effect of centrifugal force is to increase the effective weight of the stone and thus keep the string taut. Likewise, during a pull-out after a dive, a short turn or a spiral, the effective weight of the airplane and of the pilot is increased by the centrifugal force applied. This centrifugal force or acceleration is measured in units of g. G stands for gravity, 1g being the pull of the earth's gravitational field. For example, if a man weighs 150 pounds (68 kg.) at 1 g. his weight is 300 pounds (136 kg.) at 2 g. 600 pounds (272 kg.) at 4 g and so on. This increase in weight produces symptoms that

* From the Photographic Department, Mayo Clinic, Rochester, Minnesota. Received for publication April 24, 1945.

Figure 1a. The low pressure chamber; b, the human centrifuge.

are largely the result of the increased weight of the blood and the inability of the heart to pump blood to the head in opposition to such forces.

The Mayo Aero Medical Laboratory is equipped to study the three problems I have mentioned; namely, protection against extremely low temperature, the effect of g on man and the supply of adequate oxygen to the pilot. Photography is playing an important role in this work by serving as an aid to scientific investigation. Photographs are used to illustrate oral and written reports, and motion pictures are employed to explain the operation of equipment. The camera is used as a means of observing reactions and changes. Often the best point of observation is completely inaccessible to a human being, so photography offers the only means of observation. Photography is employed as a means of measuring and evaluating experiments. Motion pictures serve as an accurate method by which several people can observe the same experiment repeatedly. Thus, more accurate measurements and conclusions may be reached by keeping human error of observation to a minimum.

The camera equipment used includes three types of 16 mm. motion picture cameras, a 5 by 7 view camera and a 3¼ by 4¼ view camera. Most of the motion pictures have been made with an electrically driven motion picture camera operating at 24 frames per second. When a lighter, more compact camera has been needed, two magazine-loading motion picture cameras have been used. One of these is of the conventional spring-driven type, while the other is a compactly built, lightweight, motor-driven camera. This camera, which is used by the Army Air Corps, was described by Harrison[1]. With but few exceptions all motion pictures have been made in color, and a highly sensitive orthochromatic film is used for still pictures.

The effect of extreme cold can be studied more easily under artificial conditions than in an airplane at high altitude. The Mayo Aero Medical Laboratory is equipped to produce extremely cold temperatures in a cold chamber that resembles the refrigerated rooms used for meat storage. Temperatures as low as minus 40°F. are produced. At this low temperature picture taking is difficult. The shutter mechanism of the between-the-lens type we have available operates sluggishly after a very short exposure to this temperature, and after a few minutes the shutter will operate only on the time and bulb settings. For this reason the open-and-close flash bulb method of picture taking is the method we have used.

We have found it advisable to assemble all equipment before entering the cold chamber. Preparation should include focusing the camera, if the lens-to-subject distance is known. After several minutes ex-

posure to extreme cold, the photographer is very willing to return to normal temperature to thaw out. The camera shutter must thaw out too for after several minutes the shutter ceases to function. Before reentering the chamber sufficient time must be allowed for the shutter to operate normally and moisture condensation to disappear from the lens. There is no danger of heavy moisture condensation forming on the film if it is kept in the chamber no longer than five minutes.

It should be emphasized that one of the most difficult problems of making photographs at low temperatures is that of protecting the photographer against cold. A pair of overshoes, a sheepskin coat and a warm cap provide adequate protection for the feet, body and head. I have yet to find a glove that will provide sufficient warmth especially when gripping metal equipment and still permit enough movement of the fingers to enable one to handle the camera with even a small degree of efficiency. In my experience, warmly lined gloves made of soft leather are the most satisfactory type of covering for the hands, but even with this protection certain operations such as setting the shutter and lens or removing and inserting the dark slide, are difficult to perform.

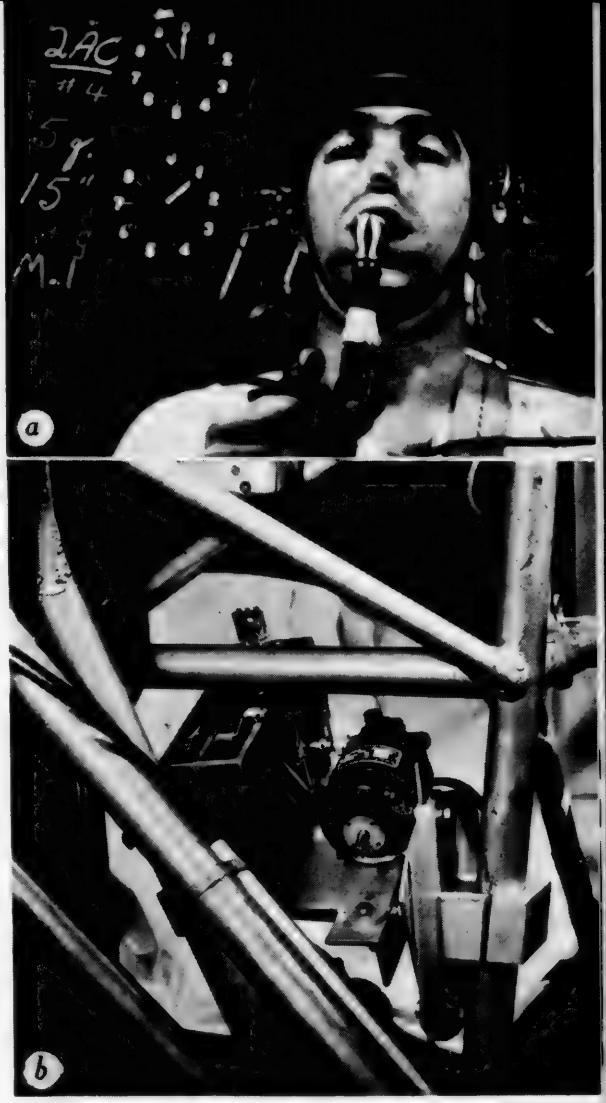


Figure 2a. Still picture made from a colored motion picture demonstrating the subject on the centrifuge; b, 16 mm. motion picture camera with electric motor drive mounted on the centrifuge.

High altitude conditions of air flight are simulated in the low pressure chamber, figure 1*a*, by removing varying quantities of air, thus simulating air pressure and oxygen content at various heights above the surface of the earth. The observer can watch the subject through porthole windows. It is not difficult to make pictures through one of these windows. A window at the end of the chamber is the most useful for

two reasons: 1. Greater lens-to-subject distance is obtained by utilizing the full length of the chamber. 2. The camera is located in a separate room that can be darkened to eliminate all reflections from the glass window. There are electrical outlets inside the chamber, so illumination is supplied by lamps placed inside. In the crowded interior, R-2 photoflood bulbs in clamp-on sockets are convenient for they occupy a minimum amount of space and provide ample illumination for making Kodachrome motion pictures. A master switch on the outside controls the R-2 lights, and an interphone system maintains contact between the cameraman, observer and subject. This is a great asset and is used to give directions and instructions to both cameraman and subject.

The Mayo laboratory is equipped with a human centrifuge to reproduce the conditions of increased g similar to those in an airplane, figure 1b. The centrifuge rotates counterclockwise on a vertical axis at a speed varying up to forty-five miles per hour in accord with the g desired. The subject rides in a cockpit located at ane end of the centrifuge. The cockpit is suspended at each end on a pivot so that the bottom of the cockpit swings out when the centrifuge is in motion. Thus, the subject sits in a vertical position when the centrifuge is stationary but assumes a nearly horizontal position when the apparatus is in motion.

The photographic problem involves making motion pictures in color of the subject's face, neck and shoulders to record visible changes and reactions[2]. In addition, it is desirable that the picture area include several recording instruments, figure 2a. The cameraman cannot ride on the centrifuge, so a motion picture camera with an electric motor drive is operated by remote control, figure 2b. To provide rigid support the camera and motor are securely mounted on a metal platform in the cockpit. The camera can easily be removed from its mounting for reloading.

The maximum distance from the lens to the subject is 3 feet (91.44 cm.) so a 15 mm., f.2.7, wide angle lens is used to secure sufficient field.

Illumination is furnished by an R-2 photoflood bulb on each side of the subject. Both bulbs must be placed 3 feet (91.44 cm.) from the subject and 2 feet (60.96 cm.) above eye level to afford the subject some protection in case a bulb breaks. In addition they must be placed outside the range of peripheral vision, for signals visible only to the subject are used as a means of determining his condition. As the camera is located below eye level, the illumination is not ideal. It has, however, proved satisfactory in the majority of cases. The camera and the lights are operated by the observer who is seated at the center of the centrifuge.

Figure 3. Apparatus for roentgenographic studies on the centrifuge.

It might be expected that the mechanism of the motion picture camera would not function properly or would break under the strain of g. After one minor breakdown had been repaired, however, the

camera continued to function satisfactorily, so it seems plausible to attribute the damage to normal wear and tear brought on more quickly by the strain of g. There is little doubt that the life of any motion picture camera would be shortened if operated continually under this strain.

A magazine-loading, spring-driven, 16 mm. motion picture camera has been used at various locations in the cockpit. It has been mounted with the axis of the lens at various angles to the direction of the force of g. We have found that under some conditions of g the camera fails to operate properly or not at all.

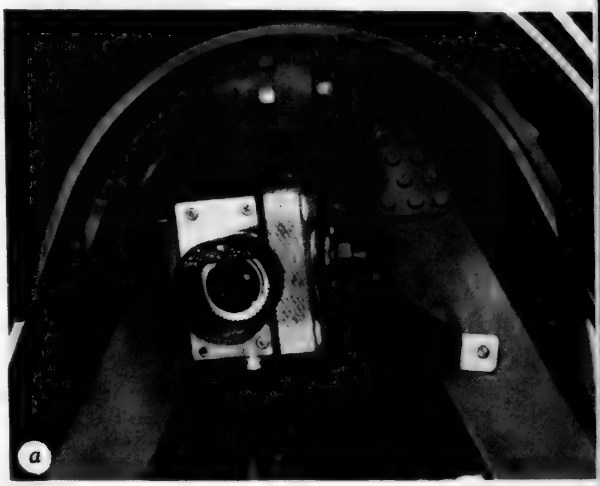
Photography is serving as an aid to the study of the effect of g in still another manner; namely, by roentgenograms.* These pictures are used to observe any internal organ that can be visualized by roentgen rays. It is necessary to make exposures at short intervals by remote control. This is accomplished by using a Robot camera to photograph the x-ray image on a fluorescent screen. The Robot camera uses 35 mm. film and can be operated to take pictures at one second intervals. These still pictures are made on the centrifuge with the x-ray tube mounted above the subject, figure 3. The subject lies on a table, and the camera, leaded glass screen and fluorescent screen are in a cabinet below the table. The camera and x-rays are controlled by the operator at the center of the centrifuge. Fluorographic film when hypersensitized with mercury vapor fumes permits an exposure of 1/5 second at f.2. Pictures are exposed with the x-ray tube operating at 85 K.V.P., 30 ma. and target screen distance of 24 inches.

Recently a request was made for motion pictures showing the effect of g produced under flight conditions. These pictures are made in a dive bomber with the subject seated to the rear of the pilot in a space ordinarily used by a gunner. The designers of the airplane certainly did not plan to make pictures within the cramped quarters of the gunner's seat. There is no room for a photographer, and difficulty was encountered in mounting the ordinary motion picture camera. Fortunately the Army Air Corps motion picture camera, which was referred to previously, was available for this use. It is driven by a small electric motor contained within the camera case and is designed to accommodate a 16 mm. film magazine. In these two respects, it ideally suits our purpose. However, the camera is equipped with a 3 inch (7.62 cm.) lens, so to secure sufficient field an adapter was constructed to accommodate a 15 mm. lens. In addition, the camera provides no method of focusing the image or a view finder to locate the subject. The field

* This work was done by Dr. M. M. D. Williams, Mayo Clinic

is located with a finder constructed of heavy wire forming a rectangle and a piece of board ½ inch (1.27 cm.) square and 3 feet 4 inches (101.6 cm.) long. Supporting wires from each corner intersect at the center of the rectangle, where one end of the board is attached. The opposite end of the board is held in proper position on the top of the camera by metal guides. The wire rectangle outlines the field contained in the picture. After the camera has been fastened in its proper position, the finder is removed. This method, although awkward, is as accurate as conventional methods. Focusing is done by measuring the lens-to-subject distance and setting the lens accordingly. Fortunately, vibration is not a factor for the motor can be throttled down when the airplane starts the dive. This reduces vibration to a point not noticeable in the pictures. Lighting conditions are not ideal since the course of the airplane places the subject alternately in bright sunlight and shadow. The only choice is to compensate between correct sunlight exposure and correct shadow exposure. Although the motion pictures thus produced will not stand critical inspection, they are the only possible means of visually observing the effect of g on the subject in aircraft.

Figure 4a. The lightweight, compact, motor-driven, 16 mm. motion picture camera mounted in the airplane as used to make motion pictures of the subject; 4b, housing and support for the motion picture camera illustrated in a. Used in this position to make motion pictures of the pilot.



When the motion picture camera is used to photograph the subject in the airplane, it is mounted on a metal plate which in turn is bolted solidly to the structure of the airplane, figure 4a. The camera is electrically controlled by the pilot.

A rigid tripod support, figure 4b, mounted on one wing of the airplane enables the motion picture camera to be used to photo-

graph the pilot during flight. Vibration has been eliminated by streamlining the supporting rods and camera housing.

Still pictures of instruments and equipment mounted within the cramped quarters of the airplane are made with a 3¼ by 4¼ view camera, figure 5. Photography in cramped quarters is much simpler with a camera of this size than with a larger one. The small camera is easier to handle and move into proper position. Because of its small size, it can often be placed farther from the subject, thus photographing a larger area. When the camera must be used close to the subject, its short focal length lens (13.5 cm.) produces additional depth of focus. The clamp-on support,† on which the camera is mounted, is an important asset. With it the camera can be placed in the precise position to produce the best photograph, and its rigidness permits long exposures so essential when small diaphragm openings are employed to secure adequate depth of field.

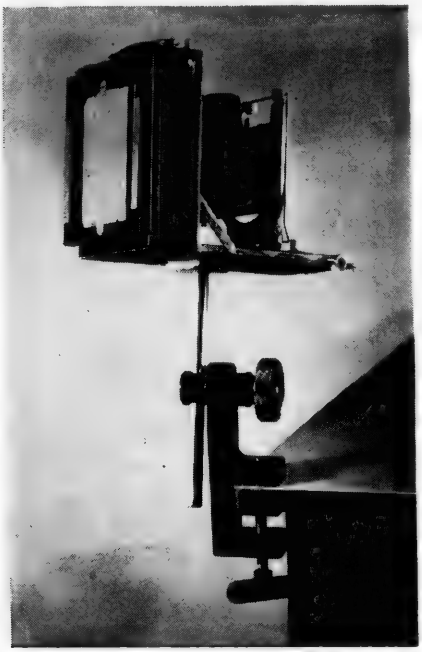


Figure 5. Clamp and 3¼ by 4¼ view camera as used to make still photographs in the airplane.

Illumination for still photography within the airplane is furnished by R-2 photoflood bulbs. The photographs are made with the airplane in the hangar and thus only controllable artificial light illuminates the equipment.

Although often the photographic assignments have seemed to be insurmountable, there has always been a method of securing suitable pictures. The services of competent machinists and technicians have been indispensible since many pictures could not have been made without the use of special camera mountings, lens adapters and electrical appliances.

† Designed by Mr. L. A. Julin, Photographic Department, Mayo Clinic, for use with the early work in aviation medicine. A similar clamp-on support is described by Fox, J. T.: Biological photomacrography with Kodachrome film. Jour. of the Biol. Photo. Assn. 11:145-151 (June) 1943.

[1] Harrison, C. A.: Wartime versatility in aerial cameras. American Photography. 39:18-21 (Mar.) 1945.

[2] Wood, E. H., Baldes, E. J and Code, C. F.: External appearance of human being during positive acceleration. The Air Surgeon's Bulletin. 2:117 (Apr.) 1945.

Microscopy and Photomicrography Of the Temporal Bone with Polarizing Films

George Kelemen, M.D.*

THE difference in the structural appearance of unstained, living, fresh and fixed tissues examined with bright-field, dark-field, ultraviolet, and polarized light, as compared with stained and incinerated tissues has been studied by Gage, Gage Day and Starett.[1] In the course of their investigations, they have concluded that each method gives a different picture of the same thing. Since each picture is only a partial representation, a mental combination of these parts is necessary to give a composite which more closely resembles the actual picture than any single representation. They emphasize the fact that even with this composite, our understanding of the real structure of living tissues and organs is still appallingly incomplete.

Examination by polarized light proved to be equivalent to a selective staining by demonstrating double refraction against isotropic elements. Polarization is superior to a stain insofar as there is no change in the original condition of the material. The appearance of any double refractory element changes with its orientation in the space; thus by this method more impressive pictures are rendered and more information gained regarding histological structure than by any other means.[2]

Von Ebner[3] was the first to use polarized light in his studies concerning bone tissue in 1875. He found that the structure of this tissue is based entirely on the distribution and properties of collagenous fibers. Collagenous fiber is characterized by double refraction in which the optical axis corresponds to the axis of the fiber.[4] When sectioned parallel to its axis, the fiber appears opaque between crossed Nicol prisms; it

* From the Department of Otolaryngology, Tufts College Medical School and the Massachusetts Eye and Ear Infirmary, Boston. Aided by a grant from the Charlton Fund, Tufts College Medical School. Received for publication March 16, 1945.

[1] Gage, Simon Henry; Gage Day, Mary, and Starrett, Clara C.: The structural appearance of unstained, living, fresh and fixed tissues and organs revealed by the bright field, the dark field, the ultra-violet, and the polarizing microscope in comparison with stained and with incinerated tissues and organs. Anat. Rec. 55: 4. Suppl. 17, 1933.

[2] Schmidt, W. J.: Polarisationsmikroskopie. In: Péterfi, Tibor: Methodik d. wiss. Biologie. Berlin 1928. I. Allgemeine Morphologie, pp. 380-417.

[3] von Ebner, Victor: Untersuchungen ueber das Verhalten des Knochengewebes im polarisierten Licht. Sitzungsber, Kais. Akad, Wiss. Wien, 3.Abt. 70:105-143, 1874.

[4] Petersen, Hans: Die Organe des Skelettsystems, In: von Moellendorff, Wilhelm: Handb. d. mikrosk. Anat. d. Menschen, II. 2:521-678, 1930.

appears bright when sectioned obliquely. A ring of collagenous fibers shows four completely opaque segments and four alternating segments of maximal brilliance. These phenomena make it possible to follow the path of collagenous fibers. Cross sections of osteons (Haversian systems) present the appearance of "Maltese crosses."

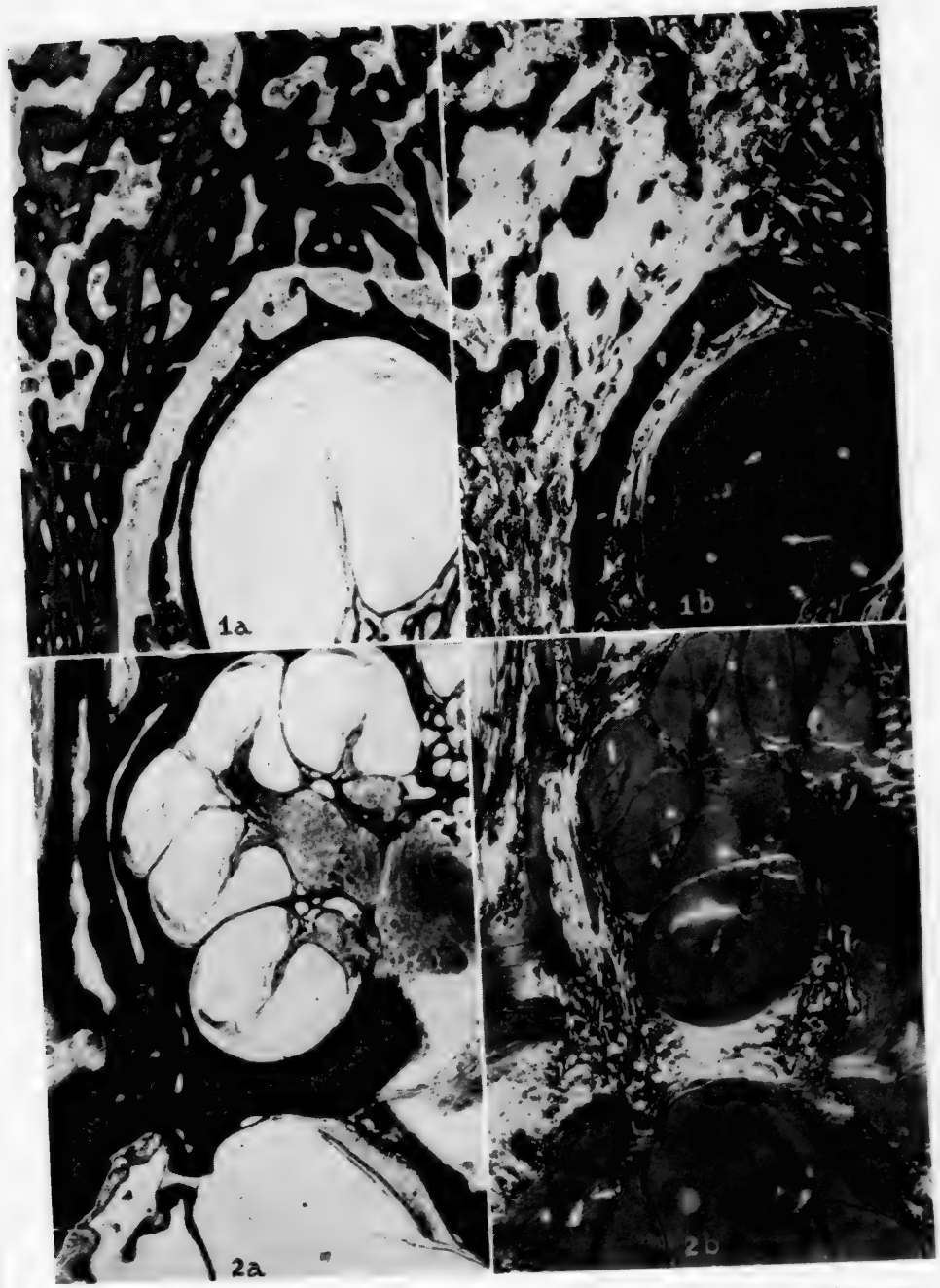
Two kinds of bone were so identified; a web-like fibril bone (called "geflechtartiger Knochen" by von Ebner[3]) and lamellary bone. In the embryonic period, the entire skeleton of mammals is composed of this web-like fibril bone, so-called membranous bone; it resembles a frozen connective tissue.[5] This is replaced in the course of the first years of life by lamellary bone. Destruction of fibril bone and replacement by lamellae produce a "breccia". This term, taken from petrology, designates a "rock composed of angular fragments of moderate or large size, cemented together" (Webster). This kind of bone is characteristic of the human skeleton as compared with mammals whose bony architecture is more regular. The whole process is more easily observed by polarized light. By this method is seen the debris which results from the course of destruction and is cemented together in the breccia. The winding of fibers around vessels, later replaced by lamellae and representing a Haversian unit, is likewise more clearly demonstrated by polarized light than by any other method; one can also differentiate the collagen in the organs with greater assurance in this way since specific staining methods for collagen will stain besides collagen many other elements.[5]

The information obtained by the use of polarized light in studying the bone structure was first applied to the special conditions prevailing in the bony capsule of the inner ear by Max Meyer[6] in 1927. The use of polarized light in investigating the problems of otosclerosis was first suggested by Weber[7] in 1930.

Even with frequent application of other selective histological methods, the study of osseous changes in the inner ear has remained principally a "hematoxylin-eosin-pathology". In this connection, polarized light is infrequently used because of technical difficulties. Preparation of the section to be observed by this method is easy, but to procure and handle the necessary polarizing apparatus may present some handicap.

Some precaution however is necessary even in the preparation of the sections. Fixation in alcohol, formol, picric acid or sublimate is permissible, but chromic acid destroys the double refractory property.[5]

[5] Petersen, Hans: Histologie und mikroskopische Anatomie. München 1924, Bd. 3, 214-262.
[6] Meyer, Max: Ueber eine eigentuemliche Art von Knochengewebe beim erwachsenen Menschen (den lamellenlosen, feinfaserigen (straehnenartigen) Markknochen) und ueber den embryonalen Markknochen. Zeitschr. f. d. ges. Anat. Abt. 1., 83:734-751, Aug., 1927.
[7] Weber, Moritz: Otosklerose im Polarisierten Lichte. (Zur Frage der Fibrillen und Kittlinien.) Zeitschr. f. Halls-, Nasen-u. Ohrenheilk, 23:415-459, July 1931.



Figures 1A and 1B. Stillborn, male, 8 mos. of intrauterine life. Cochlear capsule. A: hematoxylin-eosin, full light; B: unstained, polarized light. 16

Figures 2A and 2B. Macacus rhesus. Cochlear capsule. A: hematoxylin-eosin, full light; B: unstained, polarized light. 24

This peculiarity of chromic acid must be considered as a contraindication to its use in decalcification and with the osmium methods to demonstrate fat. After decalcification in a five per cent nitric acid solution, paraffin, celloidin, or gelatine may be used for embedding, but after sectioning, those substances such as paraffin, in which there may be double refraction, should be carefully removed. Frozen sections may be used after decalcification. According to Meyer,[6] any section between 5 and 40μ may be used. Examination is best carried out under water, alcohol, or, preferably, in a ten per cent solution of sodium chloride. When closed with wax, sections under sodium chloride can be preserved for a long time. Binocular observation is preferable. Approaching higher magnifications, contrasts are less well defined, since color components of the polarized light assume an increasing significance.

Polarizing equipment presents considerable difficulties. Usually every type of microscope has its own polarizing attachments; these are always expensive and not everywhere available. The special polarizing microscopes which eliminate several disadvantages inherent to simple polarizing attachments by the insertion of anastigmatic Nicol prisms within the tube of the shaft and other improvements are even more expensive and consequently more rare. The small size of the Nicol prisms restricts greatly the visual field.

With the use of "Polaroid" light-polarizing materials, many of these difficulties can be overcome. "Polaroid-J-Film" is a film of cellulose acetate with innumerable little needle-shaped crystals imbedded in it.[8] It is bonded between sheets of clear cellulose acetate safety film to form Polaroid-J-Film. Manufactured in sheets of any size "Polaroid can be used with any microscope and shows the phenomena of polarized light satisfactorily."[9] The small amount of film necessary is a negligible expense. We have used it in the following manner:

Microscopy. A piece of polarized film was cut corresponding to the size of the slide and placed under the slide carrying the unstained section; these were clamped together to the stage of the microscope. This piece of film served as a polarizer. A second small round piece was then cut and dropped onto the inner diaphragm of the ocular after it had been temporarily unscrewed. This piece served as an analyzer. Simple rotation of the ocular in the shaft produced opaque and bright positions. For the sake of easier orientation in the unstained section, it is advisable to reduce the iris diaphragm of the substage-condenser almost to a pinpoint aperture, while when turning into the polarizing position a somewhat larger opening will be found useful. The visual field remains entirely unrestricted by this method of polarization and

[8] Grabau, Martin: Introduction to polarized light and its application. Cambridge, Mass., 1940.
[9] Gage, Simon Henry: The Microscope, 17 ed. Ithaca, N.Y., 1943, p. 172.

is merely limited by the optical system of the microscope itself. In this way rapid survey of the entire section is greatly facilitated.

Photomicrography. One round piece of the film was fastened in front of the objective and remained immobile. A large piece was slipped into a filter carrier frame between the microscope and the source of light. This piece could be easily rotated. Since with the use of Nicol prisms or any other polarizing material, there is a loss of more than 50 per cent of illumination, the time of exposure must be longer as for example in the case of a section of the same thickness but stained with hematoxylin eosin and photographed in full light.

To eliminate as many media with different refractory properties as possible, the manufacture of slides or cover-slides from polarizing material is suggested. By inserting a round piece of polarizing sheet into the frame under the condenser which will carry colored filters, the polarizing process would be reduced to a minimal maneuver. This is of importance when examination of a long series of sections is involved.

Working on histological problems concerning the temporal bone, a wide field stereoscopic microscope for rapid orientation in the long series and stereo-photography[10] of sections is indispensable, besides the microscope used for the routine examination and photomicrography. It is welcome knowledge that a third, the polarizing microscope, can be replaced by a device of greatest simplicity practically without additional expense.

To demonstrate the results obtained by using Polaroid sheets, four photomicrographs are presented. The sections used in these pictures belong to the collection, of serially sectioned temporal bones, of Dorothy Wolff, Ph.D., whose kindness in permitting the use of these sections is gratefully acknowledged. They illustrate the contrast between sections stained with hematoxylin-eosin, photographed in unpolarized light, and unstained sections photographed in polarized light. In every instance the temporal bone was sectioned in a horizontal plane. The unstained and the hematoxylin-eosin section represent adjacent links of the series; thus, their details are comparable.

Richard W. St. Clair, head of the photographic laboratory of the Massachusetts General Hospital, rendered valuable assistance in photomicrography.

In case reproduction of strictly identical elements is desired, the unstained section must be photographed first in polarized light and then again in full light after staining. When a stained section contains details which should be observed by polarizing, the section must be

[10] Gray, Albert A.: Methods of preparing stereoscopic photomicrographs of the inner ear. Acta Oto-Laryngologica 15:408-413, 1931.

decolorized. For the purpose of this study, reproduction of two adjacent sections seemed to be sufficient.

The two pairs of pictures show the temporal bone in a new-born premature, and a monkey (macacus rhesus). From each, one pair represents the cochlear capsule and one the nucleus of the labyrinth, the solid block between the semicircular canals. The same magnification (about 38 times with a Zeiss Planar) was used in all the pictures. The slides had to be exposed to the polarized light for at least five times longer than the hematoxylin-eosin sections, with the same lamp, to the full light.

Figures 1A and 1B are taken from a stillborn male infant at around eight months of intra-uterine life. In the hematoxylin-eosin section, the large narrow spaces represent the primitive state of the ossification. The comparatively varied picture of the unstained section in polarized light can be explained partially by the fact that osteoid shows a certain degree of double refraction.

Figures 2A and 2B demonstrate the cochlear capsule of a macacus monkey (12-15 months old). In this animal, the compacta of the bone in the internal ear is much reduced as compared to that of humans;[11] there is a much higher degree of pneumatization. Rich fibrillary differentiation is seen in the wall of the cochlear capsule around the boundary between the basal and middle cochlear turns adjacent to the stapes plate. The *stereoscopic appearance* of the basilar organ produced by the polarized light is remarkable.

SUMMARY

Polarized light is a great aid in analyzing structural details in general bone histology under normal and pathological conditions.

This method revealed certain conditions in the osseous inner ear capsule which are characteristic of this region and seen in no other area of the human skeleton.

Polarizing apparatus is expensive and not always available. In the greater part of the examinations (except those where the requirements are of a very special nature), it can be replaced by "Polaroid" polarizing films which offer a method of extreme simplicity at negligible expense. One particular advantage as against the Nicol prisms is the unlimited visual field. This is especially valuable in photomicrography.

In the routine histological analysis of the temporal bone, it is desirable to include observation by polarized light. This is facilitated by the use of polarizing film.

[11] Haag, Erhard: Ueber den Bau der Labyrinthkapsel einiger Affenarten. Archiv f. Ohren-, Nasen-u. Kehlkopfkr. 136:14-23, 1933.

Early Biological Photomicrographs

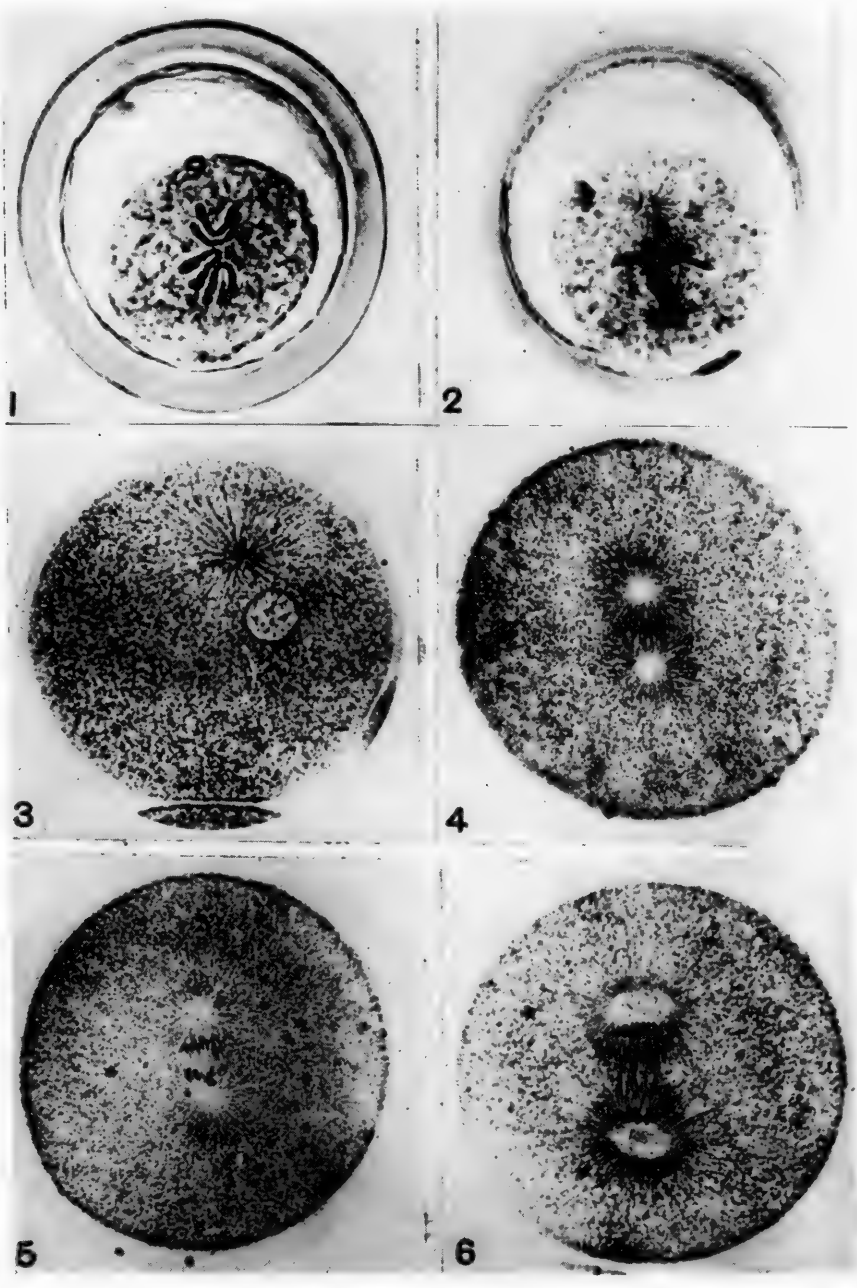
Ethel Browne Harvey, Ph.D. *

THE earliest photographs of eggs and, so far as I know, of any biological material taken through a microscope are published in a journal not readily accessible, and are probably not well known. The article, however, is a classic, and the photographs are of classic material. The author is one of the best known of the early cytologists. The paper is entitled "Nouvelles recherches sur la fécondation et la division mitosique chez l'Ascaride mégalocéphale" by Éduard Van Beneden and Adolphe Neyt, published in 1887 in the Bulletin de l'Académie royale de Belgique, 3rd série, tome XIV, no. 8. The article consists of 85 pages and six plates, four of which are reproductions of photographs, 24 in all, of different stages of the fertilization and cleavage of the Ascaris egg; the photographs were selected from 1200 "clichés" or negatives. The photographs were taken of single eggs, enlarged 750 to 780 times with a 1/16 inch water immersion lens of Powell and Lealand, and measure 5 to 6 cm. in diameter in their reproductions. The eggs were fixed in glacial acetic acid and stained with either malachite green or vesuvin (=Bismark brown) or both. No description of the photographic equipment is given. The photographs were made by Adolphe Neyt, a well known photographer of that time, interested in the application of photography to microscopy and astronomy. Figures 1 and 2 are reproductions of two photographs from one of their plates. It is obvious that their photographs were excellent, especially as to the finer details of asters and spindle fibers, and can hardly be improved upon by more modern technic. The photographs are, moreover, of total mounts, not sections. Figure 1 compares quite favorably with the recent one of a similar specimen by Oscar Richards (1942) in Volume 10 of this Journal, taken with a 2 mm. lens.

Photomicrographs of histological sections were subsequently published.[1] The earliest photomicrographs of sections of eggs to be published were also of classic material, the sea urchin. The full title of this publication is "An atlas of the fertilization and karyokinesis of the ovum," and was written by Edmund B. Wilson, one of our most eminent cytologists, with the cooperation of Edward Leaming, in-

* From the Department of Biology, Princeton University, Princeton, N. J. Received for publication March 12, 1945.

[1] E.g. the brain of the rabbit by W. H. Cox. "Imprägnation des centralen Nervensystems mit Quecksilbersalzen", Archiv. f. Mikr. Anat. 37:16-21, 1891.



Figures 1 and 2. Van Beneden and Neyt, 1887. Ascaris, entire eggs.
Figures 3, 4, 5, and 6. Wilson's Atlas of Fertilization, 1895. Toxopneustes, sections.

structor in photography at the College of Physicians and Surgeons, Columbia College. It was published in 1895 for the Columbia University Press by Macmillan and Co. in New York. The photographs were taken by Leaming with a Zeiss 2 mm. oil immersion lens, apochromat, and a No. 4 ocular, giving a manification of 950 to 1000 diameters. A Zeiss photographic apparatus was used.[2] The sections are of the eggs of the white sea urchin, Toxopneustes (now Lytechinus) variegatus, which is abundant in isolated areas at Beaufort, N. Carolina, where Professor Wilson obtained his material. The eggs were fixed in sublimate acetic, the sections were cut 3 to 5 μ thick and stained in Heidenhain's iron haematoxylin. Further details on the preparation of the material and on the photography are given in the Atlas. Ten plates are included, 40 photographs in all, measuring 9 to 10 cm. in diameter; these were selected from about 200 negatives. The photographs ("not retouched") are of such excellence that it is difficult to surpass them. Figures 3-6 give photographic copies of four of their photographs.

At about the same time that the Atlas was being prepared, Miss Katharine Foot was also taking photomicrographs of the Allolobophora egg with the help of Dr. Charles G. Fuller, an oculist of Chicago. The photographs were first published in 1898 in a paper entitled "Further notes on the egg of Allolobophora foetida" in the Zoological (later Biological) Bulletin with Miss Strobell as co-author. Miss Foot states in this paper that she showed her photomicrographs at Woods Hole in the summer of 1894, and in it she describes her technic in preparing the material and making the photographs. Although these photographs cannot compare with those of E. B. Wilson, her later ones[3] are excellent and she deserves credit for insisting upon the photographic method as filling a need in biological work which cannot be served by drawings. There is no doubt that photomicrography is invaluable in biological research for making records of quickly passing events; and these records are in such a form that they can be studied at leisure, filed and duplicated with comparatively little time and trouble.

The early history of the application of moving pictures to biological material is also a topic of interest. This subject has been adequately treated in previous numbers of this Journal by O. O. Heard (1932) and Oscar W. Richards (1933, 1939).

[2] The first Zeiss Photo-Micrographic equipment was put on the market in 1885.

[3] See especially the photographs in "A new method of focussing in photomicrography" by Foot and Strobell in Zeit. f. wissens. Mikr. 18:421-426, 1901. The paper is a discussion of their technic.

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Richards, O. W.: From photochronography and biotachygraphy to cinephotomicrography. Jour. Bio. Photo. Asso. 2:39-56, 1933.

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Van Beneden, E. et A. Neyt: Nouvelles recherches sur la fécondation et la division mitosique chez l'Ascaride mégalocéphale. Bull. de l'Acad. roy. de Belgique, 3rd sér. t. 14, no. 8, 1887.

Wilson, E. B. and E. Leaming: An atlas on the fertilization and karyokinesis of the ovum. Columbia Univ. Press, Macmillan and Co., 1895.

The author's photographs were taken from the published plates with a Leica camera. Photographs 1 and 2 were taken with the Leica Auxiliary Reproduction Device with collars and four legs, trade name Behoo; the 1:3 combination was used, for diameter of 2⅞ inch original. Photographs 3-6 were taken with a no. 3 front lens, with the distance and the heliacal focussing mount set according to the tables given in the pamphlet "Lens Tables"; here set for a diameter of 4¼ inch original. Daylight (shade) was used with an exposure of ½ sec. at f.9 on Panatomic X film.

☆

BUY WAR BONDS AND STAMPS

☆

Curvature of Field in Photomicrographs

Vernon Bryson, Ph.D.*

THE microscopist is usually aware that apochromatic lenses provide sharp focus on only a portion of the microscopic field. He knows that careful focusing on the center of the field throws the margins into a blur. Manipulating the fine adjustment will clarify the concentric margin but at the same time the field center now becomes fuzzy and out of focus.

Curvature of the field is no great problem to the observing microscopist, who is usually interested at any given moment in one restricted portion of the slide. However, the photomicrographer is intent on producing a negative all parts of which will be sharp enough for critical visual inspection of the completed print. To this end curvature of the field is undesirable, and a study of photomicrographs in almost any scientific periodical shows that there is often much room for improvement in the production of flat field illustrations.

One common technic for eliminating objectionable blurring is to make the exposure at a relatively low magnification, focusing critically on the desired area at the center of the field. When the negative is printed, enlargement is employed, and blurred peripheral areas are simply cropped off.

The same cropping effect is achieved by over-covering the negative with a high power ocular and long bellows extension before the photograph is taken. The ground glass then reveals only the focused center of an image that on projection would be found to extend beyond the dimensions of the negative on all sides. Over-covering is commonly employed to obtain a rectangular print, conforming dimensionally with the negative; rather than a circular print conforming with the microscopic field.

When a negative has been produced by over-covering and the print subsequently trimmed around the edges, there may yet remain a lack of critical definition in the center or at the margin of the finished picture. Therefore it is always best if possible to eliminate curvature of field at its source; that is, in the optical system.

* From Long Island Biological Association, Cold Spring Harbor, Long Island, N.Y. Received for publication April 23, 1945.

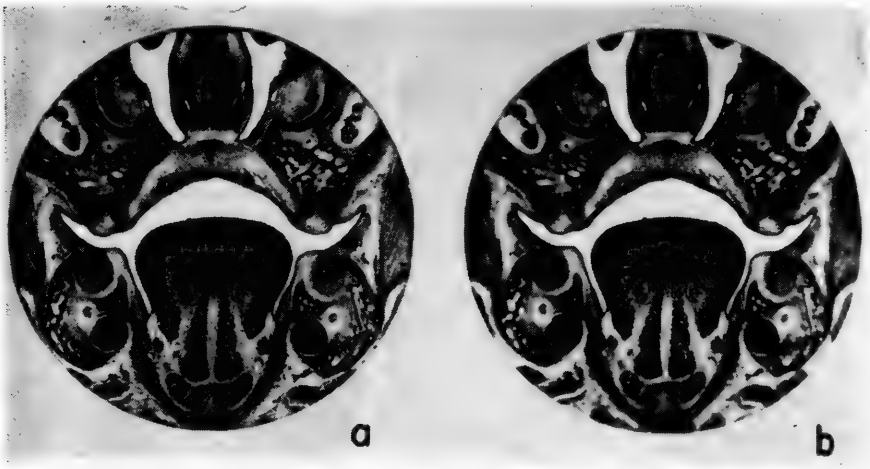

Figure 1a. Frontal section through mouth of rat embryo photographed with a 16 mm. achromatic objective. 1b, photographed with an apochromatic objective. × *16.*

For higher magnifications the use of flat field oculars especially manufactured for photomicrography affords an excellent solution to the problem.† Such lenses of both domestic and foreign make are obtainable but have not found wide use for two reasons: 1) they are expensive, and 2) they cannot be used for visual observation since the eyepoint lies below the upper lens of the ocular, restricting their use to photographic purposes.

Many photomicrographers do not possess a 16 mm. flat field lens of the Tessar type and are unable to obtain one without a priority. A few have no doubt attempted to substitute their 16 mm. apochromatic microscopic objective with inevitably disappointing results. Aside from the curvature of field inherent in apochromats, the use of these objectives without any ocular fails to correct for a difference in the degree of magnification of red and blue images. Apochromatic objectives were designed specifically for use with compensating oculars and will not produce a satisfactory photomicrograph when used alone, figure 1b.

In contrast to apochromats, the achromatic objective will produce a relatively flat field, either when used alone or in combination with a suitable ocular. Often manufactured with great skill, but generally overlooked in favor of more modern lens, achromatic objectives can be found gathering dust and tarnish on many of the older microscopes. Obtainable at a low cost the 16 mm. achromatic microscope objective

† Amphiplans—Bausch & Lomb Co.; Homals—Zeiss Co.

will take the place of a Micro-Tessar or similar lens of the same focal length.

Although no filter was employed in photographing the rat embryo shown in figure 1, a green filter covers the spectral band for which the average achromatic objective is spherically corrected and is to be recommended.

Inspection of figure 1a shows the excellent flat field obtainable with an old achromatic 16 mm. objective made by Reichert, a German firm. The lens was removed from a microscope considered too antequated for modern use. A modern apochromatic objective was substituted under identical photographic conditions to produce figure 1b. In both cases effort was made to focus as carefully as possible on the animal's tongue, in the center of the field. Compare the periphery of each print.

Today, as never before, it is difficult to obtain modern flat field oculars or objectives. Even though apochromats are superior for purely observational use, it is felt that a reminder of the value of old and rejected achromats in producing a flat field image will contribute to the success of all photomicrographers with limited equipment for whom a photograph that will "get by" is not good enough.

American Standards Association Notes

The American Standards Association Sectional Committee on Photography (*other than Cinematography*) (Z38) has published 59 approved standards over a period of four years (1941-1944). Of these, 78 per cent are dimensional standards, 19 per cent are specifications other than dimensional, and only 3 per cent are concerned with photographic technic.

Most of the dimensional standards are of interest to the manufacturers of photographic equipment and material, but one of them deals with a finished product produced by members of the B.P.A. This is the American Standard Dimensions for Lantern Slides (Z38.7.13-1944). Item 2.2 of this standard deals with the thickness of 2 x 2 inch lantern slides which is to be not greater than ⅛ inch (3.2 mm.). Assuming that the slide carriers of 2 x 2 inch projectors are constructed to take a ⅛ inch maximum, it is in the interest of all to keep the finished product within this maximum.

In the author's laboratory the following procedure is and has been the practice for binding 35 mm. Kodachromes returned in Ready-

Mounts: two adjacent edges of the Ready-Mount are trimmed 1/16 inch; the Ready-Mount placed between two sheets of 2 x 2 inch cover glass; Kodaslide Metal Binding used for the final binding. The cover glass is purchased in large quantities and its thickness may vary considerably. Recently six slides so produced were taken from a quantity in production and measured for thickness. One of the six measured 0.135 inch, exceeding the standard (0.125 inch) by 8 per cent. The other five slides varied from 0.120 to 0.127 inch, with an average of 0.123 inch. This method of binding can result in thick slides which might be too large to fit in the slide carrier, and in the future all slides produced in the author's laboratory will be inspected for thickness. Most other methods of binding produce slides which are well within the maximum, although a metal frame on the market a few years ago exceeded the standard by 3 per cent.

The above illustrates an instance where the A.S.A. is of service when producing a finished product in the biological photographic laboratory.

There are also two standards which deal with technic and while not yet approved are published for trial and criticism: Photographic Processing Manipulation of Films and Plates (Z38.8.3.) (price, thirty cents); Methods of Processing for Sensitometry of Photographic Paper (Z38.2.3.) (price, twenty cents). Both of these standards should be of interest to members of the B.P.A., and they can be obtained from the American Standards Association, 29 West 39th St., New York 18, N. Y.

LOUIS PAUL FLORY,
Yonkers, N. Y.
B.P.A. Representative.

A Rear-Projection Box for the Artist-Photographer

J. D. Brubaker*

THE rear-projection box shown in figure 1 has several uses. It is essentially a box about 10 x 10 inches inside, and 36 inches long, with a ¼ inch plate glass mirror at one end. Above the opening is a 16 x 16 inch wood frame with a ¼ inch thick

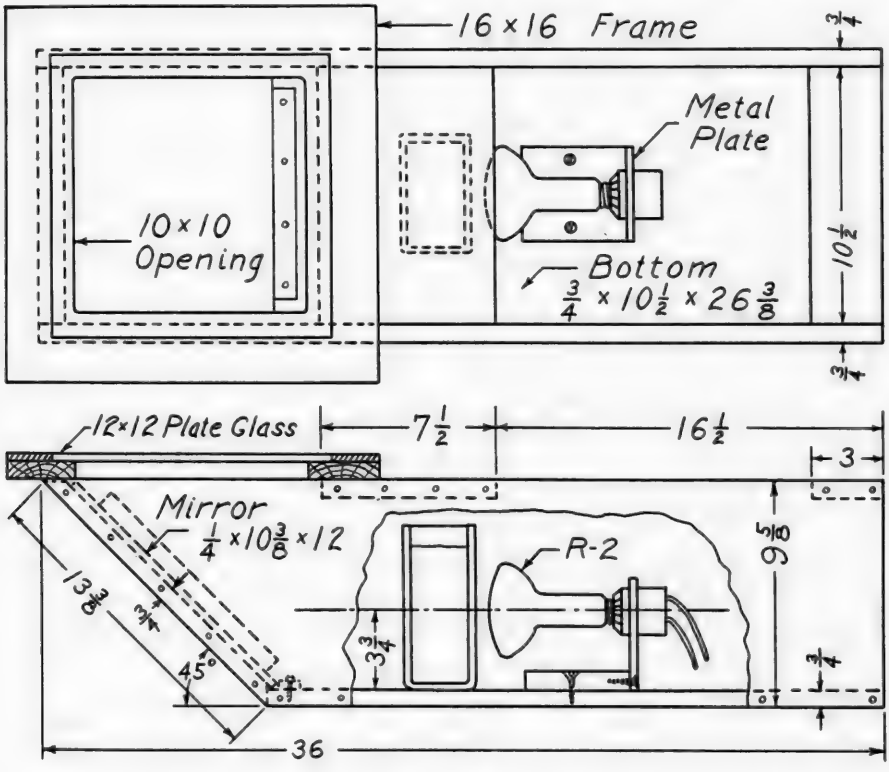

Figure 1

plate glass set flush with the top surface. The frame can be moved around like an enlarging easel. The three main uses are: (1) For tracing an image from one sheet to another, using an R-2, 500 watt

* Design and Research Engineer, 805 Greenleaf St., Evanston, Ill. Received for publication May 14, 1945.

photoflood lamp for bright illumination. (2) If a 2x2 slide projector is set up instead of the R-2 lamp, 35mm still negatives or positives (on safety film) can be projected at any magnification on the back side of the paper for enlarging or reducing art layouts to be traced on a sheet. Line-drawing illustrations and photographs can be visualized at the final reproducing scale. (3) The box, when used with the projector, can be used as a micro-film reader, projecting the image on tracing paper on the glass.

With the R-2 lamp, a straight-sided glass jar (specimen jar, goldfish bowl, or two square fruit jars) can be used as a water cell to absorb most of the heat from the lamp which would otherwise warp the working copy. A one per cent solution of copper sulphate (1 oz. to 2 qts. water), acidified with a drop or two of sulphuric acid will absorb about 98 per cent of the heat. The cell will absorb heat continuously for one-half hour before it starts to boil. Clarke[1] (p. 280) suggests a gravity fed system with extra containers of larger volume. If much work is done, a professional spotlight can be used instead of the R-2, for longer lamp life. The light is very bright from the R-2, and is about 25 foot-candles after traversing the one per cent solution and two sheets of No. 16 sulphite typewriter paper, an adequate level for close work. Clear water gives 75 foot-candles. The light is bright enough to allow working through heavy drawing paper or double-weight bromide paper.

For projecting copy, the copy is photographed on 35mm positive film, and made up into 2x2 slides. The slides are placed in the projector right side up instead of inverted in the usual position. The 45 degree mirror inverts the image. Since the image is projected from underneath, the image can be traced or measured, and compared with layouts on a sheet laid on the glass, the head or hands causing no interference with the projected image such as would occur with an enlarger projecting from above. For both tracing and projection, the transmitted light is bright enough not to require much darkening of the room; the work can be done with a minimum of eye-strain.

For direct tracing, the two sheets are held in register with scotch tape. If the 10 x 10 working aperture is too small, the whole box can be made proportionately larger with two R-2 lamps and two cells for adequate light. In use, the box is placed on a low table. The 45 degree cut-away at the front provides clearance for the worker's legs. For making drawings with the projection microscope, and for use of motion picture animation equipment, involving analogous methods, see Clarke's excellent book.[1]

[1] Illustration: Its Technique and Application to the Sciences, Carl Dame Clarke, John D. Lucas Co., Baltimore. 1940.

Photomicrography of Moving Objects Using SM Photoflash Lamp

Julian A. Carlile*

BIOLOGICAL photographers are occasionally required to make photomicrographs of living material in a state of motion. In some instances the motion is so rapid that the minimum exposure available with ordinary equipment is not short enough to prevent blurring of the image. Such an instance recently arose when it became necessary to photograph actively motile microfilarae at a magnification of about ×200. It was estimated that a minimum exposure of 1/200 second should be used, whereas the minimum exposure obtainable, using a six volt coil filament lamp, was about 1/10 second. In resolving the difficulty, use was made of the Mazda SM Photoflash Lamp, having an effective flash duration of approximately 1/200 second.

This lamp proved entirely satisfactory for the purpose and a series of photographs was made, one of which is shown in figure 1. The method may be of use to others and will therefore be described in detail.

A satisfactory arrangement of the camera, microscope, photoflash lamp, and an accessory coil filament lamp for viewing and focusing the subject, is shown diagrammatically in figure 2.

The SM is a midget size flash lamp with a single-contact bayonet base, the same as many automobile lamps. With an adapter socket it may be used in a standard medium screw socket fixture. For aligning the lamp with the microscope it is necessary to have another lamp of the same size with the same type of base, which will give a constant light and can be used on a standard 120 volt circuit. The Mazda No. 111 Photo-enlarger lamp meets these requirements perfectly. A convenient fixture for the lamps is a goose-neck desk lamp stand with a bowl-shaped reflector.

The SM flash lamp is for battery flashing only, two dry cells in series being recommended by the manufacturer. The batteries may be

* From the Illustration Division of The Rockefeller Institute for Medical Research, Department of Animal and Plant Pathology, Princeton, New Jersey. Received for publication May 17, 1945.

connected to a standard slotted outlet to fit the cord plug of the desk lamp, thus making it possible to change quickly from 120 volts for the test lamp to the battery outlet for the flash.

The slide to be photographed should be focused in the microscope. The goose-neck lamp with the 111 photo-enlarger lamp should be placed about twelve inches from the substage mirror of the microscope, directed so that the center of the beam will fall on the plane surface of the mirror. A dark neutral filter or a combination of complementary filters such as red and green should be placed in the light path close to the mirror, to reduce the light to a comfortable intensity for observation. The eyepiece is removed, and while looking straight down the center of the tube, the substage mirror is tilted until the brightest image of the light source appears to be centered in the back lens of the objective. Then, with the substage diaphragm wide open, the substage condenser is focused until the light fills the back lens of the objective evenly. The iris substage diaphragm is now closed slowly until the edge of the iris first appears to reduce the area of the light in the objective. While still observing the back lens of the objective, the lamp is moved very slightly in various directions to make sure that the light is properly centered. The lamp should now be securely clamped in position. From this time on, the positions of the main lamp, the substage mirror, the substage condenser and the substage diaphragm should not be changed. When the foregoing operations have been properly carried out and the eyepiece replaced, the image of the specimen should appear sharp and evenly illuminated. The filter should now be removed.

It is convenient to have an additional source of light for viewing the field and focusing, immediately before inserting the plate-holder and making the exposure. A lamp suitable for photomicrography, (6 volt filament, pointolite, ribbon filament, arc, or other), will serve the purpose. It is placed on the table near or beyond the microscope and directed toward a piece of plain glass, about 5x7 inches, which is placed in the path of the light from the main lamp to the substage mirror and held in a vertical position by a slotted cork or wooden block. The auxilliary lamp is adjusted so that its beam strikes the glass at about the same point as the beam from the main lamp, but from the opposite side. The eyepiece is again removed and the back lens of the objective is observed as before. It will probably not be necessary to reduce the light with filters in this case. The focusing light is aligned with the microscope by moving only the lamp and the plain glass reflector—the substage mirror must not be moved. The glass reflector may be revolved on its vertical axis and the lamp may be raised, lowered, or tilted, until the proper illumination of the back lens

of the objective is obtained. When the eyepiece is replaced, the field should appear as well illuminated as with the main lamp, although,

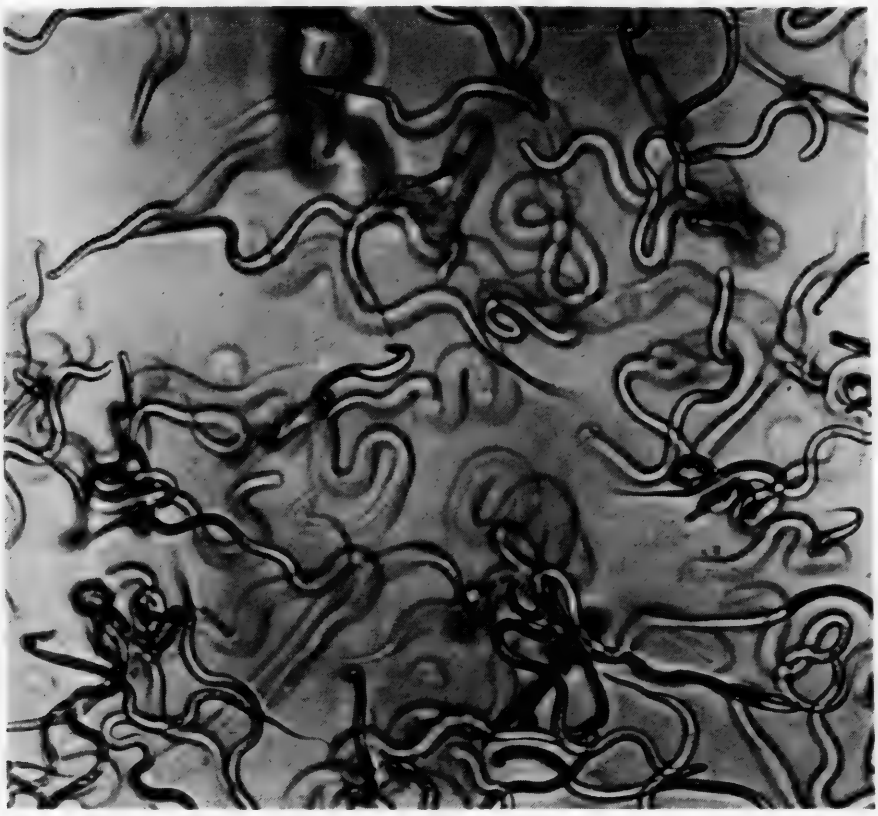

Figure 1. Dirofilaria immitis, photograph made for Dr. M. B. Franks and Dr. N. R. Stoll.

OPTICAL AND PHOTOGRAPHIC DATA:
Distance, flash lamp to substage mirror: 12 inches.
Objective: Zeiss apochromat, 16 mm., 10×, N. A. 0.30.
Condenser: Leitz, 2 cm. focal length.
Eyepiece: Zeiss Homal I.
Extension: (top of eyepiece to focal plane), 42 cm.
Linear magnification: ×225.
Plate: Wratten Metallographic (ortho), Weston rating, 16.
Developer: Kodak D-19.

perhaps not quite as bright. The auxilliary lamp and plain glass reflector should be secured in position to prevent accidental displacement.

The apparatus is now ready for use without further adjustment of the illuminating system. The 111 photo-enlarger bulb is removed from

the goose-neck lamp stand and the latter is connected to the dry cells. Then, making sure that the switch is OFF, the SM flash lamp is in-

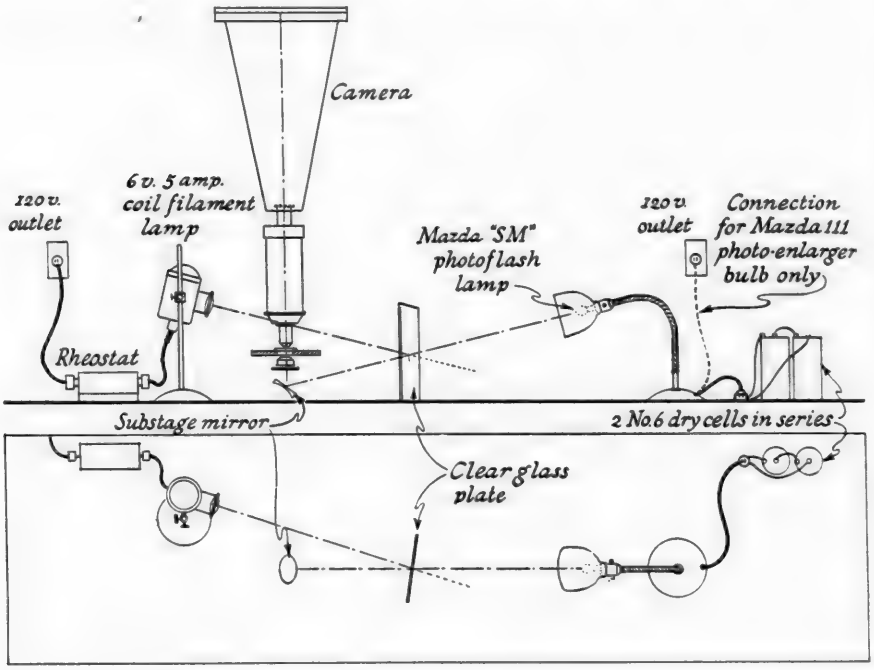

Figure 2. Diagrammatic sketch showing arrangement of apparatus.

serted. With the camera in place over the microscope, the field is selected and the image focused on the ground glass by the illumination of the reflected light from the auxiliary lamp. When the image appears to be satisfactory the plate-holder is inserted, the focusing lamp turned off, slide pulled out, SM flash lamp fired, and the slide replaced.

The SM lamp may be replaced immediately with a new one—always being sure the switch is OFF—and the operation repeated as often as desired.

Overexposure may be compensated for by the use of neutral density filters or a slower plate or film. Underexposure will require the use of a plate or film of higher speed.

Black and White Lantern Slides

F. R. Harding *

LANTERN slides are a much employed medium in teaching, but unfortunately many photographers have little or no knowledge of the factors involved in producing slides of good quality.

Lantern slides are made in two or three grades of contrast, depending upon the manufacturer. For most work, the medium grade is satisfactory. The contrast grade should be employed when flat negatives, that is those lacking in contrast, are used.

Occasionally a negative must be used which will not produce a good slide even on a contrast grade of slide. Sometimes it can be made usable by slightly overexposing the slide, developing it fully and fixing it. The slide will be much too dense for projection, but by giving it a ferricyanide bath (20 grains potassium ferricyanide in 6 ozs. water) it will reduce to normal density and will usually show more contrast than the same subject would when given normal exposure and development. When this bath is used, take the slide directly from the hypo without rinsing or draining, and bathe the slide with cotton soaked in the ferricyanide solution. When normal density is reached, place the slide back in the fixing bath to stop the action of the reducer and to remove the yellow stain in the emulsion. Any overexposed slide may be saved by this method, if the slide is left in the developer until it is fully developed regardless of its density.

There are two methods by which slides are made, contact and projection. Contact slides can be made from any negative or section of negative, not larger than the slide itself. There are two sizes of slides commonly used in the United States, 3¼ x 4 inches, which is the standard size, and 2 x 2 inches which is the miniature size.

When slides are made by contact there is danger of dust getting in, which causes transparent spots on the slide. These cannot be spotted out easily, and the elimination of the dust is difficult. Contact slides are usually made in a printing frame, and the dust collects on the glass front of the frame, on the negative, and on the slide itself. The only slides made by contact which do not suffer from dust trouble are slides of line material.

When slides are made by reduction projection, most of the dust troubles disappear. The action of reducing the original negative in

* From Children's Hospital, Boston, Mass. Received for publication April 23, 1945.
This is the second article of a series on fundamental procedure.

size by projection makes the dust spots so minute that they tend to disappear entirely.

As some more or less inexperienced photographers have had difficulty in making an enlarger act as a reducing camera a brief description of the process will be given. When a reduction (an image smaller than the negative) is being made with a vertical enlarger, and it is desired to reduce the image size, the enlarger is raised and the lens is racked down. To increase the image size, the camera is lowered and the lens is racked up. It will be noticed that the handling of the enlarger in reducing is quite different from when it is being used as an enlarger.

Some type of slide carrier must be employed in which an undeveloped slide, or a white card of the exact thickness of a lantern slide, is placed. The image is brought to a focus on this slide or card. The picture area on a 3¼ x 4 inch slide must not exceed 2¾ inches in height or 3¼ inches in width. Lantern slides must be projected with the 3¼ inch side vertical. On 2 x 2 inch slides the usable area is 1-1/32 x 1½ inches and the long dimension may be either horizontal or vertical. If a mat is made with an opening of the maximum usable size and laid on the slide during focusing, it will simplify centering the image. The image must be centered on the slide and the top and bottom of the projected image *must* be parallel with the top and bottom of the lantern slide. If there is divergence of the top and bottom *image* edges, it signifies that the enlarger lens board is not parallel with the slide holder, and it *must* be trued up before slides are made.

The slide carrier may be made of two blocks of 4 x 5 inch hardwood, ¾ or ⅞ inches thick, fastened together with the wood grains crossed to prevent warping. Thin strips may be glued to the top surface, and spaced to take a lantern slide without excessive movement between the strips. These strips should be on three sides of the block, the fourth side being left blank so that the slide may be easily removed after exposure. The top of the block should be painted matte black so that there will be no light surface under the slide to reflect light back through the slide. Thin felt or flannel should be glued to the bottom of the block to prevent slipping when slides are being placed in the carrier.

After the image is focussed, if the old undeveloped slide used as a focussing screen is turned over so that the glass side is uppermost, it will be an easy matter to "square up" and center the image on the slide, as the projected image produces a luminosity over the entire slide when the glass side is up. It becomes very easy to see the boundaries of the slide.

Negatives must be carefully masked in the negative carrier so that no free light shows beyond the negative, because the streaks of light will cause fog on the slide in the vicinity of the light.

If reducing is attempted and it is not possible to make the image small enough to fit the slide, try a lens of shorter focal length. If there is none available, an extension tube may be made to fit the frontboard and the lens placed at the outer end. This has the effect of extending the length of the bellows. As an example of what can be done in reducing an image, an enlarger with a bellows extension of thirteen inches, using a lens of four inch focal length will reduce a seven inch negative to two and five-eighths inches, which is ample for most slide reductions.

A foot operated switch is the most convenient method of making slide exposures, since it leaves both hands free for slide manipulation, shading, etc., and usually removes the necessity for employing a red or red-orange lens cap. If a fixed light has to be used, the colored lens cap must be employed in making the exposure, the cap being removed or slid to one side for the duration of the exposure. Most vertical enlargers have some form of "cap" built into the apparatus.

A Wratten Series "O" or "OA" safelight or its equivalent should be employed when making lantern slides.

There are some makeshift setups employing ordinary cameras and illuminating boxes which can be used to make lantern slides, but they are so slow and unreliable in action that it is better not to attempt to work with them.

A slide of a line subject, such as a chart, should have *black* lines on a *clear white* background. If, when the slide is made, it shows gray lines against a pale gray background it should be discarded and re-made. Either the slide was overexposed and underdeveloped or the negative was lacking in contrast, or the wrong contrast grade of slide was employed. Line subjects should always be copied on a process film which is made to be used on line material such as pen and ink drawings, graphs, printed material, etc.

When slides are made of continuous tone material, such as photographs of patients, etc., care must be taken that normal contrast is maintained. There should be detail visible in both the highlights and shadows. Far too many continuous tone slides are made with too much contrast. If there is doubt as to normal contrast, consult a normal print from the negative.

Many slides are spoiled by the manner in which they are developed. It is always wise to use the developer recommended by the manufacturer if the best results are to be obtained. Slides must be fully developed

if all the sparkle and life in the negative is to be seen on the projection screen. If an *overexposed* slide is *underdeveloped* and placed in the hypo, when it is fixed out it will appear weak (lacking in density) and flat (lacking in contrast). If the slide had been allowed to develop fully, it would have had too much density, but it could have been saved by reduction in potassium ferricyanide. An underexposed slide can never be developed to normal density. It should be discarded and another one given twice the exposure. The author has found that the best method of judging the proper density of a slide being developed is by observation of the back or glass side of the slide. The emulsion side is at no time a guide to proper development because it will be very dark in appearance. Remember that a slide is viewed by transmitted light while a print is viewed by reflected light so the slide will always appear dark if it is placed against a white paper and viewed.

Slides made by different manufacturers vary in the amount of image visible on the back when the slide is properly developed. Eastman slides show a fairly definite image on the back when development is complete. A little experimenting will soon show how to get the best results.

Never try to use a slide containing an image that is not parallel with the edges of the slide. It is most disconcerting to see a slide apparently going up hill on the projection screen.

All slides must be masked before the cover glass is bound in position. One of the simplest methods of masking is to use strips of black ½ inch wide slide binding tape. This is a gummed paper tape sold under the name of "Slide binding tape." A strip of this along each of the short dimensions of the slide and one or more strips at the top and bottom of the slide will mask it quickly and effectively. Be sure the tape masks a hair breadth into the image so that no light streaks will show on the screen when it is projected. The tape should be kept parallel with the slide edges.

Clean a piece of cover glass and place it over the emulsion side of the slide, making certain that no dust or dirt is trapped between the slide and the cover glass.

For binding the cover glass and slide together one of the best materials to use is ½ inch black cellulose acetate fiber tape. This tape requires no moistening and is easy to use. It comes in rolls of about 350 yards. Hold cover glass and slide together and stretch out about 18 inches of the tape. Lay the edge of the glass parallel to and in the middle of the tape. Revolve the slide end over end down the tape until it meets the starting point taking care to keep in the middle of the tape. Let it overlap about ⅛ inch and cut off with scissors. Now

smooth the tape on the glass edges of both long dimensions of the slide or top and bottom. Then press down the tape using the thumb and forefinger, one on each side of the slide. Now do the same on both short dimensions and if it has been done correctly the four corners will have perfectly tucked joints. Now place the bound slide emulsion side up or with the cover glass on top and with the base line of the long dimension at the bottom. Moisten a slide label and place it along the left hand side of the slide, with the thumb spot (red or black dot) at the bottom. If this has been done properly, when the slide is held in the hand with image right side up, the thumb spot should be at the left hand bottom corner. Clean the slide with a soft cloth. Never deliver a finger marked slide, it is a poor procedure, and cleaning takes but a short time.

REFERENCES

"Lantern Slides" Jour. Biol. Phot. Assn. Vol. 2, No. 4, June 1934.
Kodak Reference Handbook—Section 10.

Book Reviews

PHOTOGRAPHIC ENLARGING. F. I. Jordan. American Photographic Publishing Company, Boston, Mass. 252 pages, 7 x 10 inches. Cloth bound, with an index and formulary. $3.50.

Originally published in 1935, this deservedly popular book is brought up to date in this third edition. The entire field of enlarging technic is thoroughly covered — and specialized chapters on Paper Negatives, Bromoil, and print mounting are included along with a very practical formulary.

The Author and many other widely known pictorialists have contributed their prints for the illustrations. Anyone needing a book on enlarging will get their money's worth in this publication.

THE EDWAL PROFESSIONAL PHOTOGRAPHERS' MANUAL. 46 pages. 25c. This booklet for the profession is a compilation of many formulas, operating directions, and other useful information regarding the Edwal Photographic Chemicals.

MODERN DEVELOPING METHODS. Third Edition. 138 pages 5 x 7. 50c. Both of these are published by the Edwal Laboratories, Inc., Chicago 5, Illinois. This is a more complete book than the Professional Manual, covering elementary photographic Chemistry, Film and Print developing technic, toning, etc. It is an excellent manual, and would be useful in any darkroom, professional or amateur.

Ray Miess.

Association News

Fellows of the Biological Photographic Association

A Proposed Amendment to the Constitution

After mature consideration over a period of years, The Board of Directors believes that the time has come to create a grade of members who shall be known as Fellows of the Biological Photographic Association. A Fellowship Committee was appointed by the Board of Directors last year to draw up an amendment to the Constitution. The Committee is composed of the following members: Chairman, Arthur Proetz, Ferdinand Harding, Leonard Julin, Roger Loveland, Leo Massopust, Louis Schmidt, Lloyd Varden, Anne Shiras, Secretary. The Fellowship Committee has drawn up a proposed amendment for submission to the members at the Annual Business Meeting. If the members vote to accept the amendment, the Fellowship Committee will select the original group of Fellows; thereafter, the election of Fellows will proceed in accordance with the following amendment. The amendment is designed to recognize outstanding ability in the field of biological photography.

Article III

Membership

Shall be of two classes: Namely, Active and Fellows.

Section 1. *Active:* (This section to remain as it now stands.)

Section 2. *Fellows:* The Board of Directors may at its discretion, confer the title of Fellow of the Biological Photographic Association upon any members of the Association who in the opinion of the Board of Directors merit such distinction under one or more of the following categories:

A. Outstanding ability and craftsmanship in biological photography.

B. Original contributions in biological or related fields of photography.

C. Meritorious activity in biological photography, particularly activity which contributes greatly to the welfare of the Association.

Fellows shall have all the privileges of the Association, including the right to vote and hold office. They shall receive the Journal of the Association and their dues shall be $5.00 per annum, in advance. Fellows shall have the right to place the letters F.B.P.A. after their names as long as they remain members of the Association.

Section 3. *Honorary Fellows:* Honorary Fellowship may be conferred by the Board of Directors upon any person who, in its opinion,

has reached sufficient eminence in the collateral sciences to merit the distinction, but who is not actively and directly engaged in photography. Honorary Fellows shall have all the privileges of the Association, including the receipt of the Journal of the Association, except that they shall not vote or hold office. They shall be exempted from the payment of any dues.

ARTICLE IV

Election of Members

Section 1. Application for Active Membership, etc. (this section to remain as it now stands.)

Section 2. Election to Fellowship shall be by a two-thirds vote of the Board of Directors. A candidate for Fellowship shall have completed a written application-form setting forth his or her qualifications, which form shall require the signature of at least two Fellows before being acted upon by the Board. Applications must be received by the Secretary of the Association before a given date of any year, as specified by the Board of Directors, for consideration by the Board of Directors in that year. Applications received after this specified date shall be held for consideration the following year.

Section 3. Honorary Fellows shall be elected by a two-thirds vote of the Board of Directors. The Board of Directors shall vote on candidates annually in meeting or by mail at a time specified by the Board.

THE MEMBERSHIP YEAR

Proposed Amendment to the Constitution

At present the constitution provides for a membership year as follows:

Article III. *Membership.* Section 1, paragraph 2, under Active Membership: "The dues shall be $3.00 per year, July 1 to June 30, in advance."

Article IV. *Election of Members.* Section 1, paragraph 2: "The dues, including subscription to the Journal, shall cover membership to the first of July following, and the back numbers of the current volume of the Journal shall be forwarded to the member free of charge."

An amendment will be presented at the Annual Business Meeting to delete the words "July 1 to June 30" from Article III, and the whole of paragraph 2 in Article IV. Instead of taking in all new members as of July 1st the Directors would like to try out a system of dividing the year into four quarters (the quarters to begin September 1, December 1, March 1 and June 1). New memberships will run for one year

as of the beginning of the next quarter after each application has been accepted. In this way back issues of the current Journal need not be mailed out at odd times and at higher cost than our special postal rates.

CHAPTER NEWS

The Chicago Chapter continued as our most up and coming group by holding meetings every month of the '44-45 winter season. At some of their sessions they gave demonstrations of new processes, including color-printing. Their annual elections were held February 20th and the following officers and directors were chosen:

President ----------Dr. Jay Garner, Winnetka, Ill.
Vice-President ----------Mr. Chas. Lindsay, Loyola Medical Sch.
Secretary ----------Miss Avis Gregersen, Provident Hosp.
Treasurer ----------Mrs. Maria Elsasser Ikenburg, Univ. of Illinois Medical School
Directors--Mr. George Schechtman, Chicago School of Photography
Mr. Don. Burge, Evanston Hospital
Miss Geraldine Foster, Kaufman & Fabry

The latest program notice to come in from Miss Gregersen lists their speaker as Corp. Sydney Greene, photographer at the Vaughan General Hospital, Hines, Ill. Corp. Greene has had experience in news photography and commercial work as well as in the medical field. His subject is a timely one: "Medical Photography in an Army Hospital."

The Pittsburgh Chapter briefly reviewed new developments in photography by holding three meetings this season. No election of officers was held and no business meeting. The Chapter expects to go back to a more business-like basis when its Chairman, Sgt. Albert Levin returns from overseas.

1945 MEETING

We expect to hold an Annual Meeting this year at a center where many members can attend without need of railroad transaportation. To comply with the regulations issued by the Office of Defense Transportation we will limit the number of travelling members by asking that reservations be sent in early, and by closing the list of reservations after 50 out-of-town members have replied. We do not like the idea of shutting our doors to any members who wish to come, but this year we have no choice. So we hope you will answer early if you plan to be with us, and will let us know if, after making reservations, you find you cannot attend. You will receive a letter later giving further details about the meeting place, and about sending in reservations.

The Salon will be even more important than usual this year, since it will probably not be possible to hold a commercial exhibit. Now

is a good time to get to work on your prints—time goes faster than you realize. Participation in the Salon is one of the best ways for us to become acquainted with you professionally. HAVE YOU CHOSEN YOUR ENTRIES?

SUSTAINING MEMBERS

Some individuals who have a deep interest in the advance of scientific photography help finance a wider range of activities for the Association by becoming Sustaining Members. The privileges of Regular and Sustaining Members are the same. Either type may be chosen each year when the dues are payable.

Cammon, W. A. "Don", D.O.S.
Cameron Surgical Specialty Co.
666 West Division Street
Chicago 10, Ill.

Davidson, Emil
Clay-Adams Company
44 E. 23rd St.
New York 10, N.Y.

Flory, Louis Paul
Boyce Thompson Institute
for Plant Research
1086 Broadway
Yonkers 2, N.Y.

Garner, Dr. Jay M.
723 Elm Street
Winnetka, Ill.

Gibson, H. Lou
Eastman Kodak Company
343 State Street
Rochester 4, N.Y.

Hagaman, R. S.
Defender Photo Supply Co.
Rochester 3, N.Y.

Hill, Thos. T.
Edwal Laboratories, Inc.
732 Federal St.
Chicago 5, Ill.

Horton, Nathan S.
Ayerst, McKenna & Harrison, Ltd.
Rouses Point, N.Y.

Johnson, L. R.
1700 Standard Building
Cleveland 1, Ohio

Lester, Henry M.
101 Park Avenue
New York 17, N.Y.

Mallory, 1st Lt. Robt. III
131st General Hospital
APO 5541
% Postmaster, New York, N.Y.

Perskie, Leonard L.
Defender Photo Supply Co., Inc.
275—7th Avenue
New York 1, N.Y.

Proetz, Dr. Arthur W.
1010 Beaumont Bldg.
St. Louis 8, Mo.

Semken, Dr. George H.
16 West 85th Street
New York, N.Y.

Shiras, Miss Anne
University Office
Magee Hospital
Pittsburgh 13, Pa.

Smith, James
1721 Bushnell Avenue
S. Pasadena, Calif.

Varden, Lloyd E.
Ansco
Binghamton, N.Y.

B.P.A. OFFICERS AND COMMITTEE CHAIRMEN

President	Ferdinand Harding The Children's Hospital Boston 15, Mass.
Vice President	Stanley J. McComb Section of Photography Mayo Clinic Rochester, Minn.
Secretary	Anne Shiras University Office Magee Hospital Pittsburgh 13, Pa.
Treasurer	Stella Zimmer Photographic Department School of Medicine Syracuse University Syracuse 10, N.Y.
Editor of Journal	Leo Massopust Marquette University Milwaukee 3, Wis.
Motion Picture Committee	Dr. Oscar Richards Spencer Lens Co. Buffalo 11, N.Y.
Public Relations Committee	Dr. Arthur W. Proetz 1010 Beaumont Building St. Louis 8, Missouri
Committee for Cooperation with the Army	Major Ralph P. Creer Army Medical Museum Washington 25, D.C.
Traveling Salon	Louis Schmidt Rockefeller Institute New York 21, N.Y.
Salon Chairman	Nathan S. Horton 32nd floor, 22 E. 40th St. New York 16, N.Y.
Questionnaire Chairman	Arthur L. Smith Photographic Science Serv. Cornell University, Ithaca, N.Y.
Curriculum Chairman	Stanley J. McComb Mayo Clinic Rochester, Minn.

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